Science Library

APR 15 1938

133

VOLUME 28 NUMBER 4

APRIL, 1938

Phytopathology

An International Journal

Official Organ of

The American Phytopathological Society

CONTENTS

Rhizoctonia sheath spot of rice ..... T. C. Ryker and F. S. Gooch 233
The value of new copper sprays as fungicides for the control of apple blotch, cherry leaf spot, and apple scab—1937. K. J. Kadow and H. W. Anderson 247
The spread of onion mildew by wind-borne conidia of Peronospora destructor ..... A. G. Newhall 257
A mosaic-resistant small red bean. Donald M. Murphy and W. H. Pierce 270
Further determinations of the carbohydrate-nitrogen relationship and carotene in leaf-hopper-yellowed and green alfalfa. Howard W. Johnson 273
Asteroid spot, a new virosis of the peach. L. C. Cochran and Clayton O. Smith 278
A bacterial bud and stem rot of rocket larkspur. P. A. Ark, C. M. Tompkins, and R. E. Smith 281
Algal fruit spot of orange ..... J. R. Winston 283
Phytopathological Note 286
Mosaic resistance in Nicotiana tabacum L. E. E. Clayton, H. H. Smith, and H. H. Foster
Book review 289
Report of the Twenty-ninth Annual Meeting of the American Phytopathological Society 290
In memoriam 303
Errata, volume 27 306

Price { $6.00 per year, United States and dependencies,
$6.25 per year, Canada
$6.50 per year, elsewhere

PUBLISHED MONTHLY BY THE SOCIETY

OFFICE OF PUBLICATION

Cor. Lime and Green Streets, Lancaster, Pa.

Entered at the postoffice in Lancaster, Pa., as second-class matter.

DIRECTORY OF ADVERTISERS

AMERICAN POTASH INSTITUTE, Investment Building, Washington, D. C.	A NEW SERVICE ORGANIZATION ON THE USE OF POTASH IN CROP PRODUCTION
BAYER SEMESAN CO., INC., Du Pont Building, Wilmington, Del.	SEED AND SOIL TREATMENTS. NEW IMPROVED CERESAN. NEW IMPROVED SEMESAN JR.
BAUSCH & LOMB OPTICAL CO., 665 St. Paul St., Rochester, N. Y.	MICROSCOPES. MICROTOMES.
JOHN BEAN MFG. CO., Division Food Machinery Corp., Lansing, Michigan.	SPRAYING, DUSTING, GRADING, CLEANING, AND WASHING EQUIPMENT.
CENTRAALBUREAU VOOR SCHIMMELCULTURES, Baarn, Netherlands.	FUNGUS CULTURES FOR USE IN RESEARCH AND TEACHING
CHICAGO APPARATUS CO., 1735 1743 N. Ashland Ave., Chicago, Ill.	SCIENTIFIC INSTRUMENTS, LABORATORY SUPPLIES, AND CHEMICALS.
CLAY ADAMS CO., 25 East 26th St., New York, N. Y.	SLIDE AND COVER GLASSES. MICROSCOPIC PROJECTION AND DRAWING APPARATUS.
DIFCO LABORATORIES, 920 Henry St., Detroit, Mich.	DEHYDRATED CULTURE MEDIA.
THE GRASSELLI CHEMICAL CO., Cleveland, Ohio.	SPRAY MATERIALS AND DUSTS.
HAMMOND PAINT & CHEMICAL COMPANY, Ferry Street, Beacon, New York.	FORMACIDE FORMALDEHYDE DISINFECTANT.
MESSINGER MFG. CO., Tatamy, Pa.	CROP DUSTERS, THRESHERS AND CORN SHELLERS.
THE MOUNTAIN COPPER CO., LTD., 351 California St., San Francisco, Calif.	COPPER CARBONATE, CUPROS OXIDE AND OTHER COPPER FUNGICIDES AND INSECTICIDES.
NIAGARA SPRAYER AND CHEMICAL CO., INC., Middleport, New York.	DUSTERS, DUSTS, AND SPRAYS. KOLOFOG, POMO-GREEN.
B. G. PRATT CO., 50 Church St., New York, N. Y.	SPRAY CATALIZER FOR LIQUID AND DRY LIME SULPHUR.
ROHM & HAAS & CO., INC., 222 W. Washington Square, Philadelphia, Pa.	RED COPPER OXIDE. FORM-O-FUME FORMALDEHYDE DUST.
THE R & H CHEMICALS DEPT., E. I. Du Pont de Nemours & Co., Inc., Wilmington, Del.	P. A. C. FORMALDEHYDE.
THE SCIENCE PRESS PRINTING CO., Lime and Green Sts., Lancaster, Pa.	PRINTERS OF SCIENTIFIC JOURNALS, BOOKS AND MONOGRAPHS.
TRIARCH BOTANICAL PRODUCTS, Geo. H. Conant, Ripon, Wis.	PRESERVED PLANTS. MICROSCOPE SLIDES.
THE STAUFFER CHEMICAL CO., 420 Lexington Ave., New York, N. Y.	SULPHUR FUNGICIDES. DUSTING AND SPRAY SULPHURS.
VIRGINIA SMELTING COMPANY, West Norfolk, Virginia.	SEED TREATMENT "VASCO 4."

The American Phytopathological Society

FOUNDED 1909. INCORPORATED 1915

Officers for 1938

H. W. ANDERSON, President (1 yr.), University of Illinois, Urbana, Ill.

R. W. GOSS, Vice-President (1 yr.), University of Nebraska, Lincoln. Neb.

R. S. KIRBY, Secretary (3 yrs. term expires 1940), Pennsylvania State College, State College, Pa.

H. A. EDSON, Treasurer and Business Manager of PHYTOPATHOLOGY (3 yrs. term expires 1940), U. S. Department of Agriculture, Washington, D. C.

H. B. HUMPHREY, Editor in Chief of PHYTOPATHOLOGY (3 yrs. term expires 1940), U. S. Department of Agriculture, Washington, D. C.

Councilors for 1938

G. W. KEITT (term expires 1938), University of Wisconsin, Madison, Wis.

CHAS. CHUPP (term expires 1938), Cornell University, Ithaca, N. Y.

J. J. CHRISTENSEN (term expires 1939), University of Minnesota, St. Paul, Minn.

A. N. BROOKS (1 yr. for the Southern Div.), University of Florida, Gainesville, Fla.

J. W. HOTSON (1 yr. for the Pacific Div.), University of Washington, Seattle, Wash.

Representatives for 1938

A. A. A. S. Council (1 yr.), W. D. Valleau, S. A. Wingard.

Elector Group V, Division of Biology and Agriculture, National Research Council (terms expire 1940), E. C. Stakman (H. P. Barss, alternate).

Board of Governors, Crop Protection Institute (3 yrs.), Kenneth Kadow (term expires 1939), C. R. Orton (term expires 1938), J. G. Horsfall (term expires 1940).

Tropical Research Foundation (5 yrs.), L. R. Jones (Term expires 1940).

International Union of Biological Sciences, A. G. Newhall.

Board of Editors, American Journal of Botany, G. W. Keitt (3 yrs. term expires 1940).

Union of American Biological Societies (and Biological Abstracts), H. P. Barss, Chm., G. W. Keitt, H. A. Edson, and D. Reddick; H. B. Humphrey and R. S. Kirby (*ex officiis*).

Standing Committees for 1938

Regulatory Work and Foreign Plant Diseases. C. R. Orton, Chm., H. T. Güssow, J. S. Boyce, W. A. McCubbin, R. D. Rands, J. F. Adams, E. L. Chambers.

Extension Work and Relations. Luther Shaw, Chm., Chas. Chupp, R. J. Haskell, S. L. Pierstorff, R. S. Kirby, E. C. Stakman, G. W. Keitt, W. B. Tisdale, I. L. Conners.

Coordinaton in Seed Treatment Research. C. S. Reddy, Chm., W. E. Brentzel, M. B. Moore, H. A. Rodenhiser.

Phytopathological Classics. H. H. Whetzel, Manager; H. B. Humphrey, Editor.

Necrology. A. G. Johnson, Chm., M. B. Waite.

Investments. H. A. Edson, Chm., N. E. Stevens, Chas. Brooks, F. C. Meier, J. W. Roberts.

Donations and Legacies. F. C. Meier, Chm., E. C. Stakman, N. E. Stevens, J. G. Brown, N. J. Giddings.

New Memberships and Subscriptions. A. J. Riker, Chm., J. C. Carter, Kenneth Kadow, R. M. Lindgren, B. A. Rudolph, R. S. Kirby (*ex officio*).

PHYTOPATHOLOGY

An International Journal

Official Organ of The American Phytopathological Society

EDITORS

H. B. HUMPHREY, Editor in Chief, U. S. Department of Agriculture, Washington, D. C.
H. M. QUANJER, Editor for Europe, Instituut voor Phytopathologie, Wageningen, The Netherlands.
ANNE RATHBUN-GRAVATT, U. S. Department of Agriculture, Washington, D. C.
C. E. OWENS, Oregon State College, Corvallis, Ore.

ASSOCIATE EDITORS

GEORGE H. HEPTING, Asheville, N. C.
FREEMAN WEISS, U. S. Hort. Field Station, Beltsville, Md.
R. W. GOSS, University of Nebraska, Lincoln, Neb.
C. J. EIDE, University Farm, St. Paul, Minn.
EDNA H. FAWCETT, U. S. Department of Agriculture, Washington, D. C.
EDNA BUHRER, U. S. Department of Agriculture, Washington, D. C.
CAMILLE L. LEFEBVRE, U. S. Department of Agriculture, Washington, D. C.
T. E. RAWLINS, University of California, Berkeley, Calif.
GEO. F. WEBER, University of Florida, Gainesville, Fla.
THORVALDUR JOHNSON, Dominion Rust Research Laboratory, Winnipeg, Canada.
A. J. RIKER, University of Wisconsin, Madison, Wis.
W. J. ZAUMEYER, U. S. Horticultural Field Station, Beltsville, Md.

BUSINESS MANAGEMENT

H. A. EDSON, Business Manager, U. S. Department of Agriculture, Washington, D. C.
R. S. KIRBY, Advertising Manager, Pennsylvania State College, State College, Pa.

NOTICES

All communications regarding subscriptions and back numbers should be sent to **H. A. Edson, Business Manager Phytopathology, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.**

Subscription price. $6.00 per year United States and dependencies; Canada $6.25; other countries $6.50; current single numbers 60 cents. The journal is issued monthly beginning with Volume VIII, January, 1918.

Back Volumes IX to XXVII, inclusive, (except Vol. IX, No. 1, and Vol. X, No. 1, which are not available) unbound at $8.00 per volume. All earlier volumes obtainable only in broken numbers.

Separate Numbers will be supplied only from broken volumes, when the supply of complete volumes becomes low. Separate numbers from Volumes IX to XXVII, $1.00 per copy; from Volumes I to VIII, $2.00 per copy. The following numbers of Volumes I to VIII, inclusive, are obtainable: Volume I, Nos. 1, 4, 6, and index; Vol. II, Nos. 1, 4, 5, and index; Vol. III, Nos. 4, 5; Vol. VI, index only; Vol. VIII, Nos. 2 to 12, and index.

Requests to supply copies of the journal must be made within 60 days from date of issue. Date of issue January 15 and monthly thereafter.

Advertisements. Rates may be secured from the Advertising Manager. No indorsement of any statement of claims made in advertisements is assumed by this journal or by The American Phytopathological Society.

P.A.C. Formaldehyde

REG. U.S. PAT. OFF.

In Factory-Sealed One-Pound Cans for the Seed Treatment of Grains and Potatoes

THE factory-sealed, one-pound can of P. A. C. Formaldehyde assures the user of receiving a pure, undiluted product. It can be stored without danger of breakage, and is easily handled. The one-pound measure is the standard amount for making up seed-treating solutions according to government-recommended formulas.

P. A. C. Formaldehyde gives effective control against grain smut, potato diseases, and various vegetable diseases when used in the prescribed manner. It is a pure, full U. S. P. strength product (37% by weight HCHO). Manufactured and distributed by The R. & H. Chemicals Department, E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware.

P. A. C. Formaldehyde has been used for seed disinfection for over 20 years. It is one of the

DU PONT

R&H Chemicals

●

Phytopathologists: Fill in and mail the coupon below for a free can of P. A. C. Formaldehyde for demonstration and experimental work.

●

P.A.C.
FORMALDEHYDE
POISON
This factory-sealed one-pound can assures the purchaser of receiving an undiluted product, and facilitates use.
This registered mark is the purchaser's guarantee that the product has been made to full U. S. P. strength.

THE R. & H. CHEMICALS DEPT.
E. I. DU PONT DE NEMOURS & CO., INC.
Wilmington, Del.

Gentlemen: Please send me a free can of P. A. C. Formaldehyde for_____
(Type of work)

*Name*_____ *Position*_____

*Connection*_____

*Address*_____

YOUR ADVERTISING MANAGER SUGGESTS

that we let you know that we are the Manufacturers of the following:

Kolodust (the fused Bentonite Sulphur dusts)—with and without poisons
Kolofog (the fused Bentonite Sulphur spray)
Emulso (oil emulsion)
Tar-E-Mul (Tar Oil Wash)
Arsenate of Lead **Suspenso Lead Arsenate** **Calcium Arsenate**
Copodust **Copotex**
Pink Kolodust (for dusting peaches in the packing house)
Pomo-Green (with and without Nicotine)
Rotenone Dusts and Sprays

Also that we manufacture all standard *insecticides* and *fungicides*, and *dusting* and *spraying machinery*.

WHEN YOU BUY Niagara YOU BUY PROTECTION

NIAGARA SPRAYER and CHEMICAL CO., INC.
Middleport, N. Y.

Grain Fertilization

Must Provide

FOR HAY

Recommendations for fertilizing small grains should not only meet the requirements of profitable grain yields, but should leave in the soil enough plant food to insure the vigorous start and full nourishment of the hay crop following. Too often the hay crop is left on a "scavenger" basis.

"An optimum level of fertility greatly increased the productivity and duration of alfalfa when compared with that grown on soil moderately low in fertility. This held true whether the cutting treatments were favorable or unfavorable with respect to root storage, winter cover, and leafhopper damage."—*Graber and Sprague in "Alfalfa Management," Journal of the American Society of Agronomy, Jan., 1938.*

AMERICAN POTASH INSTITUTE, INC.
INVESTMENT BUILDING WASHINGTON, D. C.

BRANCH OFFICES

Beans Bldg., San Jose, Calif.
Life Bldg., Lafayette, Ind.
Mortgage Guarantee Bldg., Atlanta, Ga.
Yates Building, Hamilton, Ont.

RHIZOCTONIA SHEATH SPOT OF RICE

T. C. Ryker and F. S. Gooch

(Accepted for publication Dec. 8, 1937)

A disease of rice characterized by the presence of rather large, light-color spots on the leaf sheaths has been known in certain Oriental countries for a number of years. In Louisiana, a disease either identical or at least very similar to the Oriental sheath spot was apparently first observed in 1933. In the Orient, this disease is said to be caused by Rhizoctonia-like fungi, either *Rhizoctonia solani* Kühn or *Hypochnus sasakii* Shirai.

In Louisiana, probably the first isolations from sheath spot lesions were made by D. E. Ellis[1] at the Louisiana Agricultural Experiment Station in 1933. He isolated a reddish *Rhizoctonia* with which he obtained typical sheath spots by inoculation. Later, however, in 1934, Tullis (17) described the sheath spot, as it occurred in Louisiana, Arkansas, and Texas, and claimed that it was caused by a species of *Trichoderma*.

Since 1933 a study of the disease and the organisms associated with it has been made in Louisiana.

SYMPTOMS, OCCURRENCE, AND IMPORTANCE OF THE DISEASE

The sheath spot of rice is characterized by the presence of rather large, necrotic areas or spots confined almost entirely to the leaf sheaths. Spots do occur occasionally on leaves, but none has been observed on stems. A spot first appears as a reddish-brown discoloration that quickly enlarges and assumes an elliptical shape. In older stages it has a bleached, straw-color center and a somewhat broad, reddish-brown margin. The deepest color is next to the center. The lesions may further enlarge and coalesce to form irregular discolored areas. The spots are usually from 1 to 3 cm. long, though they may reach a length of 10 cm. or more. The width is usually about one-half the length. The spots usually occur above the water line and quite frequently just below the ligule. They may occur on any of the leaf sheaths, though they usually are confined to the lower ones. Sclerotia have never been observed either on or between diseased sheaths. Typical leaf-spot lesions are shown in figure 1.

The disease first appears during the latter part of July and becomes increasingly prevalent thereafter until September, with little development thereafter. The rice plants are well developed on first appearance of the disease and are usually well headed by the time of maximum development. The prevalence of the disease varies with the field and with the location in the field. It is usually more severe along the levees and in other places where the plant growth is more dense, although it may occur on isolated plants. All the commercial varieties appear equally susceptible. In 1936 and 1937 the disease was more prevalent in the prairie region of south-

[1] From notes on file in Department of Botany, Louisiana State University.

western Louisiana than in the Bayou Tèche and Mississippi River sections. In an extensive survey made in 1936, the percentage of infection in different fields varied from a trace to as high as 50 per cent. Sheath spotting also has been found on barnyard grass, *Echinochloa crusgalli*, present in rice fields.

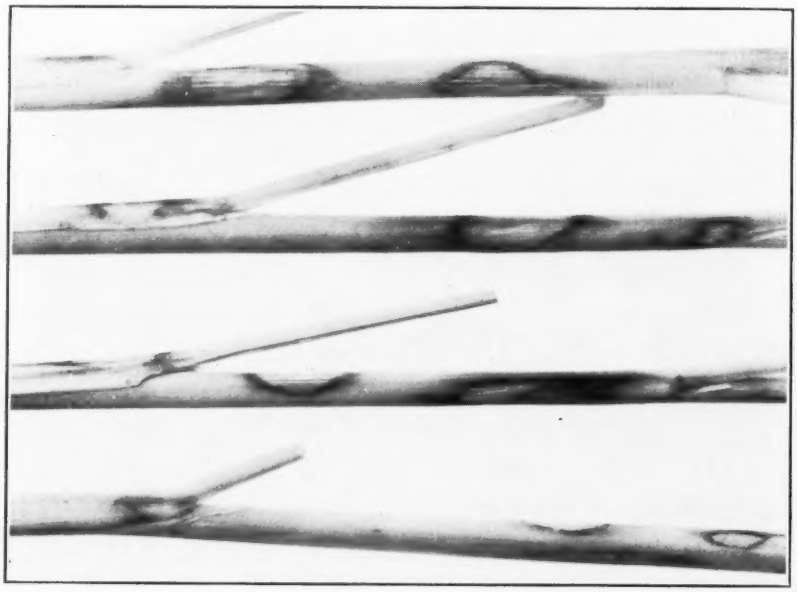

FIG. 1. Sheath spot lesions on Rexora rice.

The disease appears to be of no serious economic importance in Louisiana. Its importance lies in the fact that the functioning of certain of the leaves is impaired at heading time, a crucial period in development of the rice plant. Moreover, the infected plants may lose some of the support that the sheaths give to the stem. On the other hand, in Japan (6, 9, 15) and some of the other countries of the Eastern Hemisphere, the sheath spot of rice has been considered to be one of the more serious rice diseases, for, in addition to sheath spotting, the seedlings are affected.

THE CAUSAL ORGANISM

Platings made of diseased sheath tissue in Louisiana have invariably shown the presence of a strain of *Rhizoctonia* characterized by the production of salmon-color sclerotial masses in culture. The organism, as grown on artificial media, is shown in figure 2. It has been cultured successfully by plating small pieces of diseased tissue on plain agar, or bean-pod agar, after thoroughly washing with tap water and rinsing in sterile water. The use of surface disinfectants was not so successful, as the tissue is readily penetrated and the fungus is apparently quite sensitive to disinfectants.

In order to check closely on the causal organism, extensive collections of diseased plants were made in 1936 and 1937, and more than 1,600 platings

were made of material from 30 different collections from Louisiana and Texas. Pure cultures of *Rhizoctonia* were obtained from more than 1,000 of these. In all but 3 collections the strain bearing salmon-color sclerotia was the only one isolated. In 2 of the 3 exceptions a strain of *R. solani* with larger sclerotia and a strain of *R. zeae* (18) were isolated, along with the usual salmon-color one. In the third instance, all isolates were typical of *R. solani* and quite similar to sheath-spot isolates obtained from China and the Philippine Islands. This last collection was made in a small rice plot

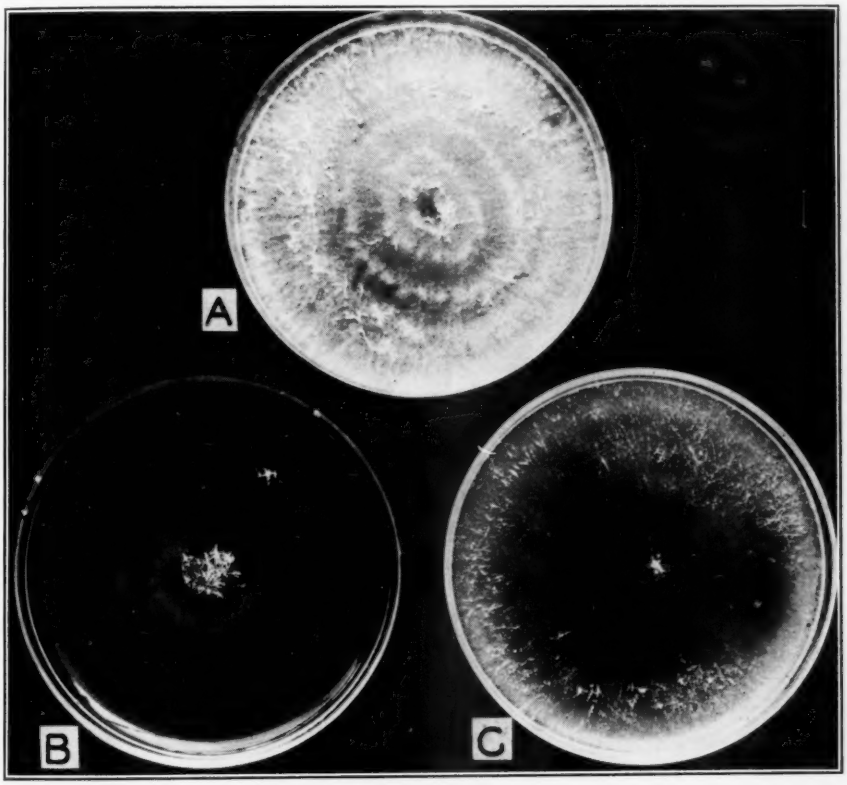

FIG. 2. Cultures of *Rhizoctonia oryzae* on different media incubated for fifteen days at 28° C. A. Bean-pod agar. B. Potato-dextrose agar. C. Cornmeal agar.

near the greenhouse in Baton Rouge, far removed from any rice field. It was further observed in this plot that sclerotia were produced between the diseased sheaths, a characteristic said to be true of the disease in the Orient. A comparison of the local isolates (1, 26, and 55) of *R. solani* with one isolate from China (104) are shown in figure 3.

TAXONOMY

A study of the literature indicates that the *Rhizoctonia* ordinarily causing the leaf-sheath disease in Louisiana has not been described, and that it is different from the organisms said to cause the same or a similar disease in the Orient.

The Oriental sheath spot is known in Japan as "Mongare byô" and has been intensively studied by workers in that country. The first report of its incidence was made in 1910 by Miyake (11), who described the causal fungus as *Sclerotium irregulare* sp. nov. However, prior to that, according to Matsumoto *et al.* (9), the fungus was collected by Sasaki on the leaves of camphor trees and was subsequently described by Shirai (16) in 1906 as *Hypochnus sasakii*. Sawada (14) in 1912, according to Matsu-

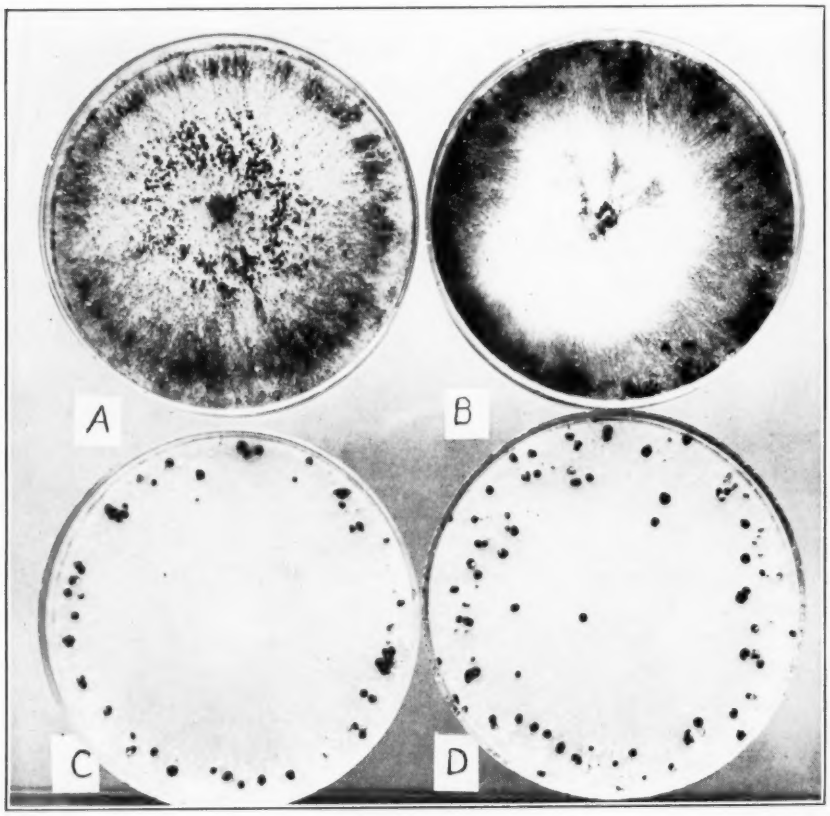

FIG. 3. Cultures of *Rhizoctonia solani* capable of producing sheath spots on rice, on potato-dextrose agar, incubated for ten days at 28° C. A. Isolate 1. B. Isolate 104. C. Isolate 26. D. Isolate 55.

moto *et al.* (9) and Wei (19) found a similar fungus on rice in Formosa and, following cross-inoculation tests, stated that *Sclerotium irregulare* Miyake on rice plants was the same as *Hypochnus sasakii* Shirai and adopted the latter name for the fungus. Sakurai (15) described 4 diseases of rice caused by sclerotia-forming fungi, one of which was that caused by *H. sasakii*. He stated that *H. sasakii* attacked the plants from June to October, producing irregular brown spots on the leaf sheaths and occasionally on the blades, and that brown sclerotia were formed on the spots or between the leaf sheaths and the stem.

In 1926, Palo (12) published his studies on a Rhizoctonia disease of rice

in the Philippines, in which sheath spotting was the typical symptom. He considered the causal organism as a strain of *Rhizoctonia solani* and similar culturally to strains of *R. solani* found on other plants in the Philippines. He also observed that the organism affected rice seedlings. Palo's fungus was later studied by Endo (2, 3, 4) in Japan and was compared with *Hypochnus sasakii*. Endo found these sufficiently alike culturally and pathogenically to be considered identical. He (3) further compared them with a strain of *R. solani* from Europe and found that the latter differed from *H. sasakii* in various respects. Workers in Japan have shown that the rice *Rhizoctonia* has a wide host range. In 1930, Ikata and Hitomi (6) described the perfect stage of the rice *Rhizoctonia* on infected leaves and sheaths of rice. They stated that the formation of basidiospores occurred at night during August and September.

In 1928, Gadd and Bertus (5) reported their studies on the diseases of *Vigna oligosperma* and other plants in Ceylon caused by *Corticium vagum* B. and C. They studied isolates from various sources, including one from sheath-spotted tissue of rice, and found that the various isolates were quite similar culturally and pathogenically. The Rhizoctonia disease of rice was further studied in India by Park and Bertus (13), and the fungus was considered by them to be *Rhizoctonia solani*. From their description, the disease and the causal organism appear to be the same as those occurring in Japan and the Philippines.

Wei (19) described the disease that occurs in China as a Rhizoctonia sheath blight and the causal organism as *R. solani*. His studies indicate that the organism he studied was the same as the Japanese strain described as *Hypochnus sasakii*. He compared the descriptions of the perfect stages given by Sawada (14) and Ikata and Hitomi (6) with that of *Corticium vagum* by Burt (1) and considered the differences insufficient to warrant species distinction.

Matsumoto and coworkers (7, 8, 9, 10) in Formosa have studied the physiology, parasitism, and taxonomy of the fungi generally referred to as *Hypochnus sasakii*. Matsumoto (7) states that a comparison of the perfect stages, when considered alone, does not show sufficient differences to justify specific separation, but these, combined with the vegetative differences, are sufficient to regard *Corticium* (*Hypochnus*) *sasakii* as distinct from *C. vagum*.

From data and observations cited in the literature and also from studies of isolates of the Oriental fungus obtained through the courtesy of Dr. C. T. Wei in China and Dr. G. O. Ocfemia in the Philippines, it seems evident that the causal fungus studied in the Orient is a large, sclerotial strain of *Rhizoctonia solani*. The Louisiana fungus, on the other hand, is distinctly different, and cannot be considered a strain of *R. solani*, despite the fact that the diseases produced on the rice plant are essentially indistinguishable. The fact that certain strains of *R. solani* and *R. zeae* have been isolated from sheath-spot material in Louisiana and are able to produce typical sheath

spotting, as will subsequently be shown, indicates the similarity of pathogenic behavior of various species of *Rhizoctonia*.

The Louisiana fungus is definitely a species of *Rhizoctonia*. The method of branching is characteristic, and a septum occurs in each branch a short distance from the main filament. Sclerotial formation, however, is quite different from that occurring with *Rhizoctonia solani*. The filaments branch separately and anastomose, finally forming sclerotial masses of hyphae with short, barrel-shape cells. Mycelium branching and sclerotia formation are shown in figure 4.

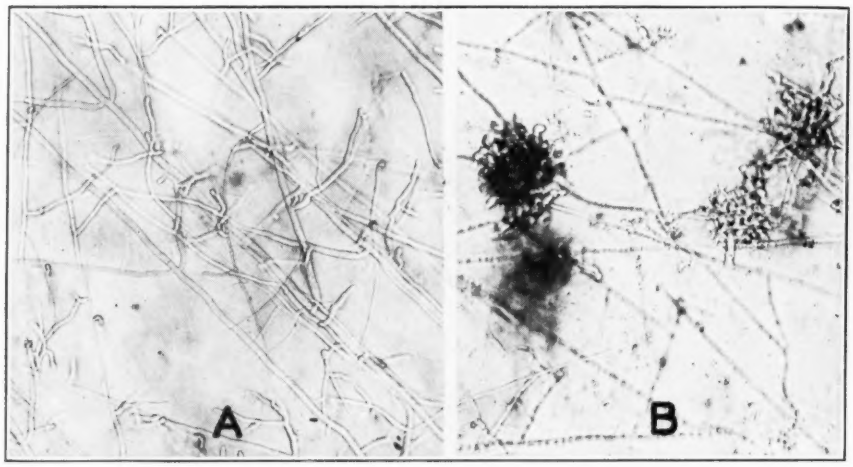

FIG. 4. *Rhizoctonia oryzae*. A. Mycelial branching in cultures three days old. B. Sclerotial formation in cultures six days old.

The sclerotial masses are of indefinite size and shape. Quite frequently they are formed along main hyphal branches, giving a crow's-foot pattern. The color of the sclerotial cell masses varies somewhat with the substrate but is a shade of salmon. According to the Maerz and Paul[2] color standard, the color is 10–B–7 on dried bean-pod-decoction agar, 10–C–6 on cornmeal-decoction agar, and 10–B–6 (sugarcane) on potato-dextrose agar. The mycelial characters also vary somewhat with the substrate. On potato-dextrose agar there is considerable aerial mycelium, there being almost none on the other 2 agars. The mycelium grows very rapidly, covering the medium in a 9 cm. Petri dish in 2 days, incubated at 32° C. Sclerotial masses usually are formed in from 5 to 7 days. No perfect stage is known for the fungus.

The fungus apparently is a new species and is described as follows:

Rhizoctonia oryzae, sp. nov. Mycelium superficial and submerged in culture, hyaline to white, granulate when young, gradually becoming clear when old. The main mycelial strands are 6 to 10 μ in width, branching at an acute angle with a slight constriction at the point of branching and with a septation a short distance from the point of constriction. The main hypha is also septate a short distance above the branch. Later,

[2] Maerz, A., and M. R. Paul. Dictionary of Color. McGraw-Hill Book Co., New York, N. Y. 1930.

short-celled, much-branched hyphae emerge at right angles from the main branches and ramify through the substrate. Certain of these after a few days develop much-thickened, short hyphae with barrel-shape cells. These hyphae intertwine and anastomose, forming masses of sclerotial cells or pseudo-sclerotia of various sizes and shape. Sclerotial masses are salmon color. Mycelium superficial and internal in leaf-sheath tissue, principally the latter. Sclerotial masses not formed on the host. Produces, in Louisiana, a sheath spot of rice, *Oryzae sativa* L. Type material deposited in Bureau of Plant Industry collections, Washington, D. C.

Isolates Studied. In making the study of sheath spot of rice, it seemed advisable to include a number of isolates of *Rhizoctonia solani* and *R. zeae*. The isolates that have been compared in the investigational work are listed in table 1.

TABLE 1.—*Isolates of Rhizoctonia made by several workers and studied by the writers in their investigation of sheath spot of rice*

Isolate	Species	Isolation	
		Source	Date
1	*R. solani*	Rice seedling, D. E. Ellis	1933
2	*R. solani*	Bean plant, L. H. Person	1931
5	*R. solani*	Sheath spot, F. S. Gooch	1935
104	*R. solani*	Sheath spot, C. T. Wei[a]	
107, 108, 109	*R. solani*	Sheath spot, G. O. Oefemia[b]	1937
25, 26, 55	*R. solani*	Sheath spot, T. C. Ryker	1936
21, 22	*R. zeae*	Sheath spot, T. C. Ryker	1936
3, 4, 9, 20, 27, 33, 34, 40, 41, 45, 46, 47, 52, 53	*R. oryzae*	Sheath spot, T. C. Ryker	1936
110	*R. oryzae*	Sheath spot, T. C. Ryker	1937

[a] Originally isolated by C. T. Wei, University of Nanking, Nanking, China, from sheath spot of rice, and obtained from E. L. LeClerg, University of Minnesota.
[b] Philippine Islands.

INOCULATION TESTS WITH TRICHODERMA

Since sheath spotting of rice had been attributed to *Trichoderma* (18), a number of attempts were made to induce infection with this fungus. In these tests isolates of *Trichoderma* obtained from rice and from other plants were used. Rice plants were inoculated by spraying with spore suspension and by placing the fungus mycelium on the host tissue. In no case was sheath spotting induced.

INOCULATION TESTS WITH RHIZOCTONIA

To obtain information on the pathogenicity of different isolates of *Rhizoctonia*, many inoculation tests have been conducted. Two methods of inoculation have been used. In one, the inoculum was placed on or in the soil in which rice plants were growing, while in the other the inoculum was placed between the leaf blade and the stem near the ligule. In the latter case the inoculum consisted of the fungus mat formed on bean-pod infusion from which most of the nutrient material had been removed by rinsing with sterile water.

Experiment I. A test was conducted to compare and test the pathogenicity of a strain of *Rhizoctonia solani* (isolate 1) originally obtained from a rice seedling, and one of *R. oryzae* (isolate 4). Four-gallon pots were filled

with soil and sterilized with steam. Pure cultures of the organisms on an oat-wheat medium were mixed with the soil and then planted with rice of the Blue Rose variety. Two pots were planted with each isolate and 2 kept for controls. The seeds were planted on May 6, 1936.

On August 11, typical sheath spots were appearing on the plants in the pots inoculated with *Rhizoctonia oryzae*. By August 11, 70 of the 100 shoots in the 2 pots had well-developed spots, all above the water line. Plants in the pots inoculated with the isolate of *R. solani* developed no spots, though mycelium was present on the lower leaf sheaths. The controls bore no spots.

This experiment was repeated; pots were planted on August 15 and plants were grown to maturity, heading about the middle of October. No sheath spots developed from inoculation with either of the 2 *Rhizoctonia* isolates. It is possible that the low temperature was responsible for the lack of infection.

Experiment II. The same cultures of *Rhizoctonia solani* (isolate 1) and *R. oryzae* (isolate 4) were used in another test. Full-grown Blue Rose plants growing in 4-gallon pots were inoculated the first week in August by placing the oat-wheat inoculum on the soil between the plants. Two pots were inoculated with each of the 2 isolates and 2 were treated with sterile oat-wheat mixture for controls. After inoculation, half of the pots were placed in a moist chamber for 33 hours, while the others were left uncovered. No sheath spots developed on plants inoculated with the *R. solani* isolate or on the controls. Sheath spots were present on the 5th day on plants inoculated with *R. oryzae* and placed in the moist chamber, and, after 6 days, on the plants not so treated. Of the 69 shoots in the 2 pots, 70 per cent showed definite spots. The sheath-spot lesions developed above the water line and quite commonly just below the ligule.

Experiment III. Another test was conducted to compare the pathogenicity of various *Rhizoctonia* cultures by the direct-inoculation method. Two cultures of *R. solani* (isolates 1 and 5) and 3 of *R. oryzae* (isolates 3, 4, and 9) were used. From 10 to 13 well-developed rice plants (Fortuna variety) growing in pots were inoculated with each isolate by placing bits of the inoculum in the leaf axis near the ligule. After inoculation the pots were placed in a moist chamber at 32° to 35° C. for 31 hours and then removed to an outdoor cage. At the time of removal from the moist chamber in many cases the sheath tissue at the point of inoculation had a water-soaked appearance, and 24 hours later these areas showed the typical symptoms of sheath spot. At the end of 5 days, 100 per cent of the plants inoculated with the *R. oryzae* isolates had sheath spots, 6 of the 10 inoculated with isolate 1 had spots, while no spots developed on the controls, or on those inoculated with isolate 5. Infection usually occurred on the sheath below the point of inoculation and usually on the inner epidermis of the sheath. Only rarely did infection take place through the outer epidermis, even though the inoculum was in direct contact with it.

The above experiment shows that certain strains of *Rhizoctonia solani*,

under favorable conditions, are able to produce sheath spot symptoms similar to those produced by *R. oryzae*.

Experiment IV. In the foregoing experiments only a few isolates of *Rhizoctonia oryzae* were used. It seemed desirable to determine the pathogenicity of a large number of sheath-spot cultures in order to find out whether isolates of *R. oryzae* varied to any extent and also to compare them with isolates of other species of *Rhizoctonia* isolated from sheath-spot tissue. Ten cultures of *R. oryzae* (isolates 20, 27, 33, 34, 40, 41, 45, 46, 47, 52), 2 cultures of *R. zeae* (isolates 21, 22), and 2 cultures of *R. solani* (isolates 25, 26) were used. This experiment was run in 2 series, being started on August 25 and August 27, 1936, respectively.

In the first series, rice plants in pots were inoculated by placing bits of mycelium back of the leaf sheaths. After inoculation the pots were placed in a moist chamber at a temperature of 32° to 35° C. for a period of 30 hours and then removed to an outdoor cage. In series 2, the oat-wheat inocu-

TABLE 2.—*Pathogenicity on rice of a number of sheath spot isolates when tissue was inoculated directly and when the inoculum was placed on the soil surface*

Isolate	Method of inoculation	Variety	Total number shoots	Percentage with sheath spots
20	Direct	Fortuna	12	41.7
	Soil	Blue Rose	29	68.9
21	Direct	Fortuna	13	84.6
	Soil	Blue Rose	33	0.0
22	Direct	Fortuna	10	100.0
	Soil	Blue Rose	22	0.0
25	Direct	Fortuna	11	9.1
	Soil	Blue Rose	26	7.7
26	Direct	Fortuna	12	66.6
	Soil	Blue Rose	31	64.5
27	Direct	Fortuna	13	100.0
	Soil	Blue Rose	24	81.6
33	Direct	Blue Rose	12	100.0
	Soil	Blue Rose	28	100.0
34	Direct	Blue Rose	13	92.3
	Soil	Rexora	9	66.6
40	Direct	Blue Rose	14	100.0
	Soil	Rexora	11	72.7
41	Direct	Blue Rose	13	84.6
	Soil	Rexora	10	40.0
45	Direct	Blue Rose	47	72.3[a]
	Soil	Rexora	11	90.9
46	Direct	Blue Rose	43	72.1[a]
	Soil	Blue Rose	13	83.8
47	Direct	Early Prolific	15	80.0
	Soil	Blue Rose	13	83.8
52	Direct	Colora	10	50.0[b]
	Soil	Blue Rose	11	100.0
53	Direct	Colora	13	53.8[b]
	Soil	Rexora	10	60.0
Control	Soil	Blue Rose	11	0.0

[a] Shoots were so numerous in the pot that some were missed at time of inoculation.

[b] The upper parts of the sheaths of many of the plants were not in close contact with the stems.

lum was placed on the soil surface. The pots were held in a moist chamber controlled at a temperature of 32° to 33° C. for 48 hours and then removed to the outdoor cage. One pot of well-developed plants was used for each isolate in each series and a pot of nontreated plants was used for a control. It was not possible to use a single rice variety in this test (Table 2).

Where the tissue was inoculated directly, the plants were showing water-soaked areas at the time of removal from the moist chamber and maximum infection was obtained in 7 days. Where the inoculum was placed on the soil surface the plants were showing some infection in 5 days, with maximum infection after about 20 days.

The *Rhizoctonia oryzae* isolates were all highly pathogenic and infection was obtained by both methods of inoculation. On the other hand, cultures of *R. zeae* were highly infectious when the inoculum was placed on the host tissue, but not when placed on the soil surface. The cultures of *R. solani* that were used were mildly to moderately pathogenic, some infection being obtained by both methods of inoculation. The symptoms obtained with all cultures were similar to those observed in the field. Reisolations were made of tissue infected with isolates 20, 21, 22, 25, 26, 27, and 33, and in all cases what appeared to be original organisms were obtained.

Experiment V. Pure cultures of *Rhizoctonia oryzae* (isolate 110) and of *R. solani* (isolates 55, 104, 107, 109) were used in a series of tests conducted in 1937. Isolates 107 and 109 had been obtained from Dr. G. O. Ocfemia and had been isolated from sheath-spot-infected rice plants in the Philippines. Plants were inoculated by placing inoculum behind the leaf sheaths and also by placing it on the soil.

All of the cultures were highly virulent and maximum infection was obtained. All produced essentially the same type of injury, the typical sheath spots characteristic of the disease. The isolates of *Rhizoctonia solani*, however, produced a somewhat larger leaf spot than did the *R. oryzae* isolate, and in the tests in which the inoculation was applied to the soil caused a temporary wilting of the plants. The wilting occurred a very short time after inoculation.

The similarity of the symptoms of sheath spot, as produced by *R. solani*, *R. oryzae*, and *R. zeae* in artificial inoculations, is shown in figure 5, A–D.

Experiment VI. As strains of *Rhizoctonia solani* are known to attack many plants other than rice and are particularly important in "damping off" of vegetable crops, it seemed advisable to try the rice isolates on some of these plants. Tests were conducted on pepper, tomato, eggplant, and bunch beans. Pure cultures were mixed with the soil in wooden flats and in pots and then planted with the seed. Pure cultures of *R. oryzae* (isolates 4, 9, 20, 27, 33), of *R. zeae* (isolate 21), and of *R. solani* (isolates 1, 2, 26, 55, 104, and one that was a mixture of cultures originally isolated from "damped off" pepper plants) were used.

The culture mixture from pepper was the only one of the group that affected germination and subsequent growth of pepper, tomato, and egg-

plant. This completely inhibited the germination of eggplant and reduced by about one-half the germination of tomato and pepper.

Special attention is called to the infection produced on bean plants. Germination was not affected nor were lesions present on any of the stems of plants inoculated with any of the isolates of *Rhizoctonia oryzae* or *R. zeae*. On the other hand, all of the *Rhizoctonia solani* isolates affected the

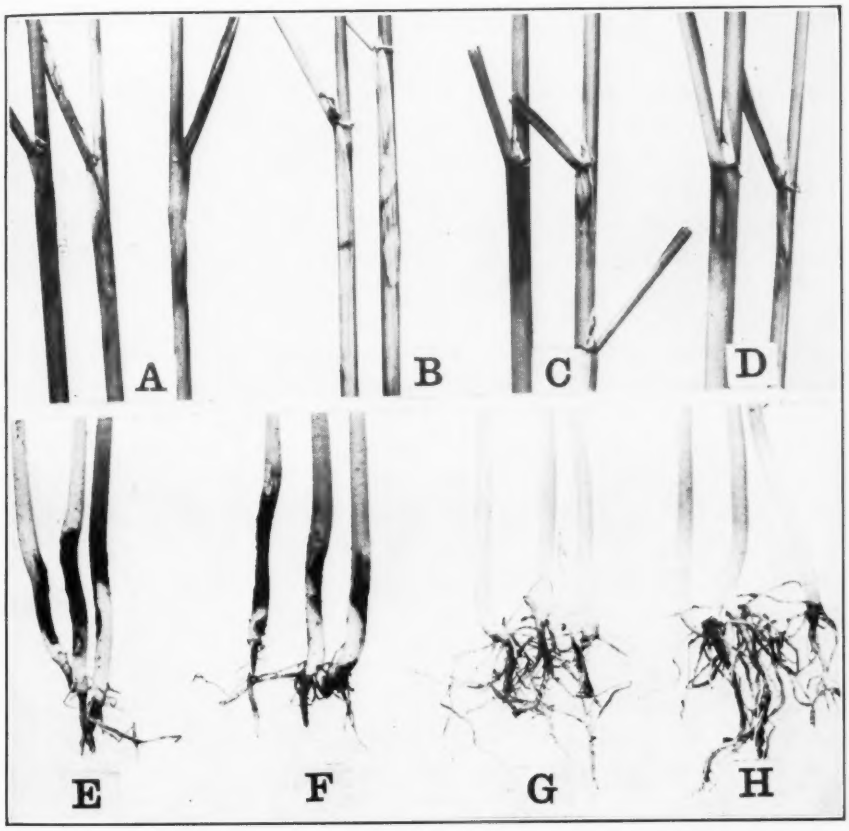

FIG. 5. A–D. Sheath spots on rice produced by four different isolates of Rhizoctonia. A. *R. solani* (isolate 104). B. *R. solani* (isolate 55). C. *R. oryzae* (isolate 27). D. *R. zeae* (isolate 21). E–H. Injuries produced on young bean plants following inoculation with *Rhizoctonia solani* and *R. oryzae*. E. *R. solani* (isolate 2). F. *R. solani* (isolate 104). G. *R. oryzae* (isolate 5). H. Control.

bean plants very seriously. Germination was materially reduced and lesions were present on most of the young plants that did develop. These differences emphasize the distinction between *R. solani* and *R. oryzae*. Representative seedlings of this experiment are shown in figure 5, E–H.

Experiment VII. Two tests were conducted to determine whether or not any of the *Rhizoctonia* isolates would reduce the germination of rice seed or cause a seedling blight. Four-gallon pots, filled with soil and then steam-sterilized were inoculated with pure cultures of *R. solani*, *R. zeae*, and *R. oryzae* (the same isolates used in Experiment VI). Two pots were used

with each isolate in the first test and 3 in the second. In each pot were planted 100 Blue Rose rice seeds previously sterilized 4 minutes in a 1–1,000 corrosive sublimate solution in 50 per cent alcohol. The tests were started on February 17 and March 5, 1937, respectively.

Two of the *Rhizoctonia solani* isolates (isolates 1 and the mixture from "damped-off" pepper plants) definitely reduced germination. In the pots inoculated with these cultures there were about one-third as many plants as in the controls. There was also a small amount of seedling blight in these pots.

The other isolates had no effect on germination. Under the conditions of the experiment *Rhizoctonia oryzae* was not a factor in seedling blight.

RELATION OF TEMPERATURE TO FUNGUS GROWTH

Preliminary studies on the temperature relations of *Rhizoctonia solani* and *R. oryzae* showed that the optimum for growth of *R. oryzae* was close to 32° C., while for the isolates of *R. solani* it was nearer 28° C. The following experiment was designed to check these findings more closely.

Pure cultures of *Rhizoctonia solani* (isolates 1, 2, 26, 55, 104), *R. zeae* (isolate 21), and *R. oryzae* (isolates 4, 9, 20, 27, 33) were grown on bean-pod agar. When the cultures filled the Petri dishes, discs 5 mm. in diameter were cut from the margins of the colonies and transferred to freshly poured potato-dextrose agar plates and then incubated in triplicate at the following temperatures: 10, 15, 20, 24, 28, 32, and 35° C. The diameters of the resulting colonies were measured daily. Most isolates at optimum temperature for growth covered the plates by the end of 48 hours. The growth rates for *R. oryzae* and *R. zeae* were essentially the same. There was very slight growth at 10° C., good growth at 24° to 35° C., with an optimum close to 32°. There was only a very slight drop in the growth rate at 35° C. On the other hand, *R. solani* developed better at somewhat lower temperatures. There was slight growth at 10° C., good growth at 24° to 32° C., with an indicated optimum between 28° and 32° C. and a very sharp drop in growth at 35°. The strains of *R. solani* with small sclerotia (isolates 1 and 2) grew somewhat slower than did the strains with large sclerotia (isolates 26, 55, and 104). This experiment was repeated with essentially the same results. The growth curves of three isolates, 1, 4, and 104, representative of the three species of *Rhizoctonia*, are shown graphically in figure 6.

DISCUSSION

In the Eastern Hemisphere a sheath spot of rice, which seems to be very common and frequently serious, has been known for some years. In some of the Oriental countries this disease is said to be caused by *Rhizoctonia solani* and in others by *Hypochnus sasakii*. From a study of the literature, however, it would seem that the Oriental investigators have been working with a single organism, a strain of *R. solani* having large sclerotia.

A sheath spot of rice also occurs in Louisiana. While it has symptoms

indistinguishable from the Oriental disease, it seems to be of minor importance. The fungus which is responsible for most of the sheath spotting in Louisiana is also a *Rhizoctonia*, but one that is definitely different from the *R. solani* reported from the Orient. This fungus seems to be different enough to be regarded as a distinct species and in this article is described as new under the name *R. oryzae*. Strains of *R. solani* and *R. zeae* that are capable of producing sheath spots have also been found on rice in Louisiana, but these occur so infrequently that they seem to be of little importance.

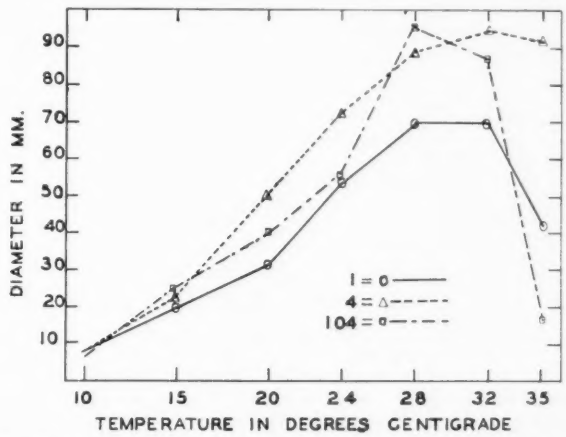

FIG. 6. Graph showing the average diameters of two isolates of *Rhizoctonia solani* (1 and 104) and one isolate of *R. oryzae* (4) on potato dextrose agar at various constant temperatures at the end of 50 hours.

These conclusions are based on a study of many hundreds of collections and isolations from rice and inoculation tests in which cultures from China and the Philippine Islands have been included.

Rhizoctonia oryzae is entirely distinct from the *Rhizoctonia* strains ordinarily found in Louisiana soils, the ones that attack a wide range of vegetable and field crops and cause such troubles as "damping off." It has not been possible to obtain infection on such crops as pepper, eggplant, tomato, and beans with this fungus.

Inoculation tests with pure cultures of *Trichoderma*, the fungus that Tullis has reported as the causal organism of the rice sheath spot, have been negative. While species of *Trichoderma* are common in Louisiana soils, present evidence indicates none of them is responsible for the sheath spot.

SUMMARY

The symptoms and causal organism of a sheat spot of rice in Louisiana are described.

Evidence is presented to indicate that the disease is caused by a hitherto-undescribed species of *Rhizoctonia*.

The organism is given the name ***Rhizoctonia oryzae***, sp. nov.

LOUISIANA AGRICULTURAL EXPERIMENT STATION
BATON ROUGE, LOUISIANA.

LITERATURE CITED

1. BURT, E. A. The Thelephoraceae of North America. XV. Corticium. Ann. Mo. Bot. Garden **13**: 173–354. 1926.
2. ENDO, S. Ueber die sklerotienkrankheit der reispflanzen in der Philippinen. Jour. Plant Protect. **14**: 6 pp. 1927. (In Japanese.) (Abst.) Rev. Appl. Mycol. **7**: 266. 1927.
3. ————————. Comparative studies on the morphology and physiology of Japanese and Philippine Hypochnus, as well as *Hypochnus solani*. Agric. Studies **14**: 3 pp. 1930. (In Japanese.) (Abst.) Rev. Appl. Mycol. **11**: 1. 1932.
4. ————————. On the influence of the temperature upon the development of Hypochnus. Ann. Phytopath. Soc. Japan **2**: 280–283. 1930. (Abst.) Rev. Appl. Mycol. **10**: 815. 1931.
5. GADD, C. H., and L. S. BERTUS. *Corticium vagum* B. & C. The cause of a disease of *Vigna oligosperma* and other plants in Ceylon. Ann. Roy. Bot. Gard., Peradeniya **11**: 27–49. 1928.
6. IKATA, S., and T. HITOMI. On the mode of primary infection through sclerotia and field observations on basidiospore formation in *Hypochnus sasakii* Shirai of rice plants. Jour. Plant Protect. **17**: 12 pp. 1930. (In Japanese.) (Abst.) Rev. Appl. Mycol. **10**: 55. 1931.
7. MATSUMOTO, T. Some remarks on the taxonomy of the fungus *Hypochnus sasakii* Shirai. Trans. Sapporo. Nat. Hist. Soc. **8**: 115–120. 1934.
8. ————————, and S. HIRANE. Physiology and parasitism of the fungi generally referred to as *Hypochnus sasakii* Shirai. III. Histological studies in the infection by the fungus. Jour. Soc. Trop. Agric., Formosa **5**: 367–373. 1933.
9. ————————, W. YAMAMOTO, and S. HIRANE. Physiology and parasitism of the fungi generally referred to as *Hypochnus sasakii* Shirai. I. Differentiation of the strains by means of hyphal fusion and culture in differential media. Jour. Soc. Trop. Agric., Formosa **4**: 370–388. 1932.
10. ————————, ————————, ————————. Physiology and parasitism of the fungi generally referred to as *Hypochnus sasakii* Shirai. II. Temperature and humidity relations. Jour. Soc. Trop. Agric., Formosa **5**: 332–345. 1933.
11. MIYAKE, I. Studien über die Pilze der Reispflanze in Japan. Jour. Col. Agr., Imp. Univ. Tokyo **2**: 237–276. 1910.
12. PALO, M. A. Rhizoctonia disease of rice. I. A study of the disease and the influence of certain conditions upon the viability of the sclerotia bodies of the causal fungus. Philippine Agriculturist **15**: 361–375. 1926.
13. PARK, M., and L. S. BERTUS. Sclerotial diseases of rice in Ceylon. I. *Rhizoctonia solani* Kühn. Ann. Roy. Bot. Gard., Peradeniya **11**: 319–331. 1932.
14. SAWADA, K. (On *Hypochnus sasakii*.) Formosan Agr. Expt. Sta. Spec. Bull. 80 pp. 1912. (In Japanese.)
15. SAKURAI, M. (On the sclerotial disease of rice.) Ehime Agr. Expt. Sta. Pub. 1. 51 pp. 1917. (In Japanese.) (Abst.) Bot. Abst. **10**: 195. 1922.
16. SHIRAI, M. (On *Hypochnus sasakii* n. sp.) Bot. Mag., Tokyo **20**. 1906. (In Japanese.)
17. TULLIS, E. C. Trichoderma sheath spot of rice. Phytopath. **24**: 1374–1377. 1934.
18. VOORHEES, R. K. Sclerotial rot of corn caused by *Rhizoctonia zeae* n. sp. Phytopath. **24**: 1290–1303. 1934.
19. WEI, C. T. Rhizoctonia sheath blight of rice. College of Agriculture and Forestry, University of Nanking (China) Bull. 15 (n. s.). 21 pp. 1934.

THE VALUE OF NEW COPPER SPRAYS AS FUNGICIDES FOR THE CONTROL OF APPLE BLOTCH, CHERRY LEAF SPOT, AND APPLE SCAB—1937

K. J. KADOW AND H. W. ANDERSON

(Accepted for publication December 20, 1937)

No spray is so universally recommended and at the same time condemned as our old stand-by, Bordeaux mixture. In spite of the fact that it has been the subject of intensive study ever since its introduction as a spray in 1882, little has been accomplished in eliminating the evils so commonly associated with its use. Its effect upon the normal physiological functions of plants is a matter of common knowledge. Likewise, we understand quite well the conditions under which it causes chemical burning, as well as desiccation resulting from excessive water loss.

Actuated by the knowledge of the shortcomings of Bordeaux, many workers have been busy in the last few years trying to find a suitable substitute for it among the so-called "insoluble" copper compounds.

The introduction of so many new materials recommended for such a variety of purposes has resulted in the usual confusion and contradictions. The aftermath of such a situation is the necessity for carefully done comparative tests under a wide variety of conditions and environments. Such tests over a period of years usually produce the necessary "testimonials" of any material's performance.

Literature reviews on this general subject have been given by Roberts[1] and by Marsh.[2] Since their papers were published, additional work has appeared in PHYTOPATHOLOGY and in bulletins of the Arkansas, Michigan, and Ohio Agricultural Experiment Stations and of the Delaware State Board of Agriculture.

We realize that the data herein reported represent only one season's results, but we feel completely justified in presenting them in that the season was ideal for the comparison of spray materials. The severity of the diseases under consideration bears out this contention.

MATERIALS AND METHODS

The trade name of the materials considered in this year's program, the active ingredients of each, and the companies that supplied them are as follows:

Name	*Principal active ingredients*	*Furnished by*
Bordeaux mixture	Copper sulphate	Purchased
Oxo Bordeaux	Copper sulphate	Ansbacher-Siegle Corp.
Basi Cop	Basic copper sulphate	Sherwin-Williams Co.
Coposil	Copper calcium-copper zinc silicate	Calif. Spray Chem. Co.

[1] Roberts, J. W. Recent developments in fungicides: spray materials. Bot. Rev. **2**: 586–600. 1936.

[2] Marsh, R. W. Some recent American work on the copper fungicides. Sci. Hort. [Wye, Kent, Eng.] **5**: 60–66. 1937.

Name	*Principal active ingredients*	*Furnished by*
Copper phosphate	Copper phosphate	Monsanto Chemical Co.
Cupro-K	Copper oxy chloride	Röhm and Haas Co.
Cuprocide 54	Cuprous oxide	Röhm and Haas Co.
Z–O	Copper ammonium silicate	Nichols Copper Co.
Bordeaux "34"	Basic copper sulphate	General Chemical Co.
Copper Hydro 40	Copper hydroxide	Chipman Chemical Co.
Special Copper	Basic copper sulphate	Niagara Sprayer & Chemical Co.
66a	an organic sodium sulphonate plus copper sulphate	National Aniline & Chemical Co.
Liquid lime sulphur	various forms of sulphur	Purchased

Each material was used as recommended by the company that furnished it, unless otherwise stated. All sprays were applied with power machines at a pressure of 400 to 600 pounds. Notes were taken every week or 10 days throughout the season concerning the general tree and fruit condition.

The season may best be described by saying that it was ideal for the development of apple scab, apple blotch, cherry leaf spot, and spray injury caused by water-soluble chemicals. In addition to frequent showers, there were numerous misty days, as well as heavy dews at night. The actual temperature and precipitation for the vicinity of Urbana are shown in figure 1, but the graph does not convey an accurate picture of climatological conditions unless the heavy, muggy weather be taken into consideration.

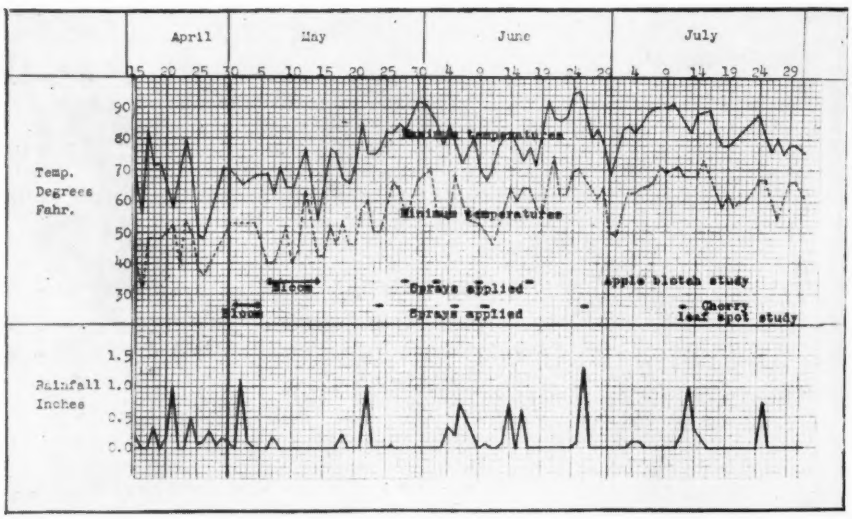

FIG. 1. Record of temperature and rainfall, Urbana, Illinois, April–July, 1937.

THE RELATION OF NEW COPPER MATERIALS TO APPLE BLOTCH SPRAYS

In this experiment the objectives were to evaluate the various copper materials from the standpoint of blotch (*Phyllosticta solitaria*) control, spray injury, and compatibility with fixed nicotine (Black Leaf 155), which is currently being recommended for codling-moth control on early apple varieties in Illinois.

The experiments were conducted in the orchards of Fred Heaton (southern Illinois, New Burnside) and George Livingston (Savoy, 3 miles south of Urbana).

Aside from a little injury to the leaves caused by Cuprocide 54, no significant results were obtained from the plots in southern Illinois. In the nonsprayed checks there was less than 1 per cent of blotch or codling-moth injury to the fruit and, accordingly, the details of this experiment will not be given.

All trees used in the Savoy (Livingston orchard) apple-blotch experiment were of the Duchess variety and were especially selected for the presence of numerous viable blotch cankers on branches and twigs. The actual sprays applied, with dates of application, are given in the following spray schedule.

TABLE 1.—*Schedule of sprays applied to Duchess apples in the Livingston Orchard, Savoy, Illinois (Spray schedule No. 1)*

Plot No.	Materials used[a]	1st Cover 5/27/37	2d Cover 6/2/37	3d Cover 6/9/37	4th Cover 6/17/37	5th Cover 7/6/37	6th Cover 7/16/37
1	Black Leaf 155	—	—	6	6	6	6
		No fungicide applied after calyx					
2	Copper sulphate	4	4	4	4	—	—
	Lime	6	6	6	6	—	—
	Black Leaf 155	—	—	6	6	6	6
3	Bordeaux 34	1½	1½	2	2	—	—
	Zinc sulphate	½	½	¾	¾	—	—
	Lime	½	½	¾	¾	—	—
	Black Leaf 155	—	—	6	6	6	6
4	Oxo Bordeaux	6	6	4	4	—	—
	Black Leaf 155	—	—	6	6	6	6
5	Basi Cop	2	2	3	3	—	—
	Black Leaf 155	—	—	6	6	6	6
6	Copocil	2	2	3	3	—	—
	Black Leaf 155	—	—	6	6	6	6
7	Copper phosphate[b]	2	2	3	3	—	—
	Lime	4	4	5	5	—	—
	Bentonite	2	2	3	3	—	—
	Black Leaf 155	—	—	6	6	6	6
8	Cupro-K	3	3	4	4	—	—
	Black Leaf 155	—	—	6	6	6	6
9	Cuprocide 54	2	2	2	2	—	—
	Black Leaf 155	—	—	6	6	6	6
10	Copper Zeolite	2	2	3	3	—	—
	Black Leaf 155	—	—	6	6	6	6
11	66a	2	2	3	3	—	—
	Black Leaf 155	—	—	6	6	6	6
12	Copper Hydro 40	2	2	4	4	—	—
	Black Leaf 155	—	—	6	6	6	6
13	Niagara Copper	2	2	3	3	—	—
	Black Leaf 155	—	—	6	6	6	6
14	Check	No sprays applied after calyx					

[a] All trees in the experiment received one early scab spray of flotation sulphur, as well as lead arsenate (3), lime (3), and flotation (16), as a calyx application. All materials expressed as pounds in 100 gallons of water.

[b] Used at ½ recommended strength by mistake.

The first two cover sprays were applied at strengths recommended for apple-scab control. This was done, since apple-scab studies also were being conducted in this orchard, and application of materials of the same strength to both experiments greatly facilitated the task of applying the sprays. The third and fourth cover sprays were as recommended for blotch by the companies that furnished the materials, unless otherwise stated.

The records include all the drops and picked fruit from 2 trees in each plot. Since the drops in no instance appeared related to spray injury, but, instead, to the lack of codling-moth control, and, since the differences between individual trees in a given plot were insignificant, the results (Table 1) are listed in percentages and based upon the total fruit examined in each plot.

It may be observed (Table 2) that blotch was extremely severe in the

TABLE 2.—*Value of insoluble copper sprays as possible substitutes of Bordeaux mixture for the control of apple blotch. Experiment at Savoy, Illinois, on the variety Duchess, 1937*

Material used[a]	Per cent blotch on		Spray injury to	
	Fruit	Petioles[b]	Fruit[c]	Leaves
Black Leaf 155 only	92.0	95.0 50% leaf fall	0.0	None
Bordeaux Black Leaf 155	0.7	Trace	3.0	Severe
Bordeaux 34 Zinc sulphate and lime Black Leaf 155	2.4	3.0	0.7	Trace
Oxo Bordeaux Black Leaf 155	1.6	5.0	0.4	None
Basi Cop Black Leaf 155	1.0	Trace	41.0	Moderate
Copocil Black Leaf 155	4.5	6.0	4.0	Light
Copper phosphate Lime and bentonite Black Leaf 155	3.1	15.0	Trace	Trace
Cupro-K Black Leaf 155	2.8	5.0	2.0[d]	Trace
Cuprocide 54 Black Leaf 155	2.5	Trace	49.0	Severe
Copper Zeolite Black Leaf 155	1.2	5.0	0.9	None
66a Black Leaf 155	17.0	30.0 15% leaf fall	Trace	None
Copper Hydro 40 Black Leaf 155	1.9	5.0	Trace	Trace
Niagara Copper Black Leaf 155	1.4	5.0	4.0	Moderate
Check—Unsprayed	97.0	95.0 60% leaf fall	0.0	None

[a] See Spray Schedule No. 1 for details of applications.
[b] Estimated on October 6—about 6 weeks after harvest.
[c] Only the injury of commercial importance was recorded.
[d] Nearly all fruit showed a little specking, but it was of no commercial concern.

plots (1 and 14) that did not receive a fungicide for its control; in fact, it was the most severe that it has been in Illinois for several seasons. Fruit from all nonsprayed Duchess trees in the general vicinity of Urbana was almost worthless from a commercial point of view. Under such conditions it was indeed gratifying to obtain such excellent control with so many of the insoluble copper compounds. Of all the materials tested, 66a (Plot 11) was the only one that did not give satisfactory control of blotch. In this plot the infected fruit, leaves, and petioles were badly spotted, while in all other sprayed plots the infected organs showed only a few isolated lesions each.

In all the experiments herein discussed, copper phosphate was used by mistake at one-half the concentrations recommended; but, in spite of this fact, it gave good control of blotch on the fruit and leaves. The petioles, however, were quite badly diseased. Further tests of this spray would certainly be justified.

Several of the materials as now recommended produced injury on both the fruit and foliage. Injury of commercial concern was caused to both fruit and foliage by Cuprocide 54, Basi Cop, Bordeaux mixture, the special copper from Niagara Sprayer and Chemical Company, and Coposil. Cupro-K was about on the border line of safety in this test, since a large portion of fruit showed a few typical copper specks but not enough of them to reduce the grade or marketability of the apples. It caused no noticeable injury to the leaves.

The data concerning the influence of the various copper compounds on the control of codling moth by Black Leaf 155 are not considered significant because of the light infestation by worms and the variation of infestation between trees in any given plot.

Thus, both from the standpoint of spray injury and apple-blotch control, the copper compounds listed below were found to be entirely satisfactory for use in the Illinois apple-blotch spray schedule this year. The materials and concentrations used per 100 gallons of water were Bordeaux 34, 2 pounds, with zinc sulphate, $\frac{3}{4}$ pound and lime $\frac{3}{4}$ pound; Oxo Bordeaux, 6 pounds; Copper Zeolite, 3 pounds; Copper Hydro 40, 3 pounds; Cupro-K, 3 pounds; and possibly copper phosphate, 4 pounds, with lime, 6 to 8 pounds and bentonite, 4 pounds.

STUDIES ON THE CONTROL OF CHERRY LEAF SPOT, 1937, AT UNIVERSITY FARM, URBANA, ILLINOIS

Because of diseases, insect pests, and climatic conditions, very few cherries are grown commercially in Illinois. Accordingly, any comprehensive studies on the control of cherry leaf spot (*Coccomyces hiemalis*) would hardly be justified, except that such a study supplies additional evidence in the general process of evaluating fungicides. It is with this in mind that the following experiment was undertaken.

The plots were located on the university farm at Urbana, Illinois, and were composed of Montmorency, Early Richmond, and Dyehouse, varieties of sour

cherry. Each week after the first application was made, records of the general tree condition and cherry leaf spot were made. Because of irregularity in size and general condition of individual trees, no records were secured on the effect of the various sprays on fruit size.

Leaf spot appeared a little earlier this year than usual and, as a result, was established in all plots, on the leaves within three feet of the ground, before any sprays were applied. In some of the plots the materials definitely burned out the spots. In others the fungus remained viable or would spread slowly during the spraying season and very rapidly after the last spray was applied. The applications were made on May 25, June 5, 10, and 26, and on July 12. Only a few plots were sprayed on June 5, when a driving rain interrupted the procedure. The rest of the plots were sprayed later in the day, between showers. In several instances the materials were not thoroughly dry before further rains fell (Fig. 1). Because of this condition all plots were sprayed again on June 10, which was as soon as other work would permit. All other sprays were timed at about 2-week intervals.

Although records were taken of the actual percentage of leaf fall in each plot and on the percentage of leaves remaining on the trees that were diseased, these data will not be presented because in many cases they give the wrong impression as to the actual plot condition. This is due largely to the fact that it was often difficult to differentiate clearly between defoliation resulting from spray injury and that caused by cherry leaf spot.

In the plot ratings here presented, each material is rated on the basis of 1 to 10; 1 indicating that the plot was in very good condition throughout the

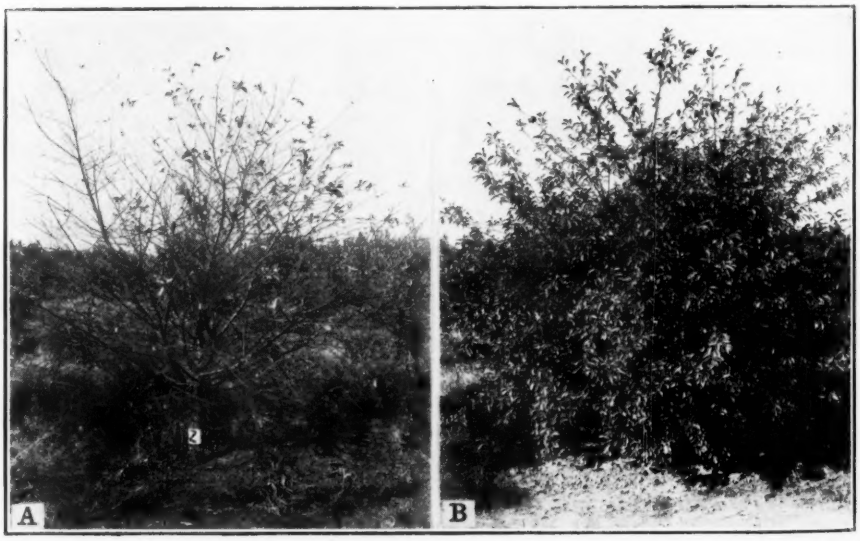

FIG. 2. A. Nonsprayed check. Most of the leaves were off this three two weeks before harvest. This was a very bad leaf-spot year in Illinois. B. Tree sprayed with Bordeaux 34, zinc sulphate, and lime at the rate of 1½ lbs., ½ lb., ½ lb. to 100 gallons of water. This was one of the most successful sprays in the experiment. It gave almost perfect control of leaf spot without spray injury.

season, whereas 10 relates to the condition of the nonsprayed checks, which were almost defoliated two weeks before harvest.

DISCUSSION OF CHERRY SPRAYING RESULTS

Based on the results of this year's cherry leaf-spot studies, conducted under conditions especially conducive to spray injury and the development of cherry leaf spot, it appears that some of the new copper fungicides have definite promise as substitutes for Bordeaux mixture. The 3 sprays that controlled cherry leaf spot without causing commercially significant injury

CHERRY LEAF SPOT—GENERAL PLOT RATINGS, 1937

Plot rating	Comments and summary
10	*Nonsprayed Checks* (Fig. 2, A) Trees in very bad condition. They were defoliated within the first week of June and remained so throughout the season, except for a few leaves that continued to develop on the tips of the branches. Even these leaves became diseased soon after they appeared. About 90 per cent of leaves off.
1	*Bordeaux 34*, 1½ lbs.,[a] with *zinc sulfate*, ½ lb. and *lime*, ½ lb. (Fig. 2, B) [a] Weights given are based on 100 gallons of spray. This was one of the best looking plots in the experiment. Except for a little browning on the under surface of the leaves, there was no injury. Early leaf spot infections burned out. Excellent leaf color. About 2 per cent of the leaves fell during season.
2	*Niagara Special Copper*, 2 lbs. Early in the season this plot showed considerable spray injury to the leaves. It has given excellent control of leaf spot throughout the season. The plot appeared in good condition late in the season. The leaves showed considerable browning on their under surface. Eight to 10 per cent of the leaves fell because of early season injury. This material has promise, but must be made safe before it is used for leaf spot control.
2	*Copper Hydro 40*, 2 lbs. This plot showed a little injury early in the season, but at no time was it of any great commercial concern. Underside of leaves showed considerable browning. Leaf color good. Excellent control of leaf spot throughout season. Material should be made a little safer before it is recommended to growers. About 5 per cent defoliation because of early season injury.
8	*66a*, 2 lbs. No spray injury to leaves, but a dark specking of the fruit associated with the lenticels was observed. At concentrations used, this product was of no value for leaf-spot control. Leaves started falling before harvest and soon thereafter over 80 per cent were off. Late in the season, plot was about 95 per cent defoliated, with remaining leaves infected.
4	*Copper Zeolite*, 2 lbs. Only evident spray injury to leaves was a moderate browning of dorsal surface. Leaf color good. Some black specks on the fruit associated with lenticels. Injury as a whole of no importance. Plots sprayed with this material looked very good until shortly after harvest. After the last spray application was made, leaf spot began to defoliate, eventually causing about 60 per cent of the leaves to fall. Most of those remaining were diseased. Either this material does not adhere to the leaves well or else concentration was too low to be effective.
6	*Cuprocide 54*, 2 lbs. From the start this plot showed severe spray injury. All leaves off color with under surfaces badly browned. Good control of leaf spot. Between 40 per cent and 50 per cent leaf fall due, apparently, to spray injury.

CHERRY LEAF SPOT—GENERAL PLOT RATINGS, 1937—(*Continued*)

Plot rating	Comments and summary
	Cupro-K, 2 lbs. (Fig. 3, A) A little spray injury early in the season. Leaves show some browning on underside. Injury of doubtful commercial significance. Excellent control of cherry leaf spot. Early leaf spot all burned out. Leaf color good. About 3 per cent defoliation early in season as result of injury.
2	*Copper Phosphate*, 2 lbs., with *lime*, 4 lbs. and *bentonite*, 2 lbs. Used at one-half recommended strength. A little browning on underside of leaves only evidence of spray injury. Leaf color excellent; deeper green than in any other plot. About 15 per cent of leaves fell because of leaf-spot infections. At strength used, material seems unable to stop the disease once it is established.
2	*Coposil*, 2 lbs. This plot showed considerable spray injury, early in the season, that resulted in about 10 per cent leaf fall. Remaining leaves showed some browning; slightly off color. Leaf-spot control good; early spots burned out. Coposil needs to be made safe for use on cherries, but has very definite promise.
2	*Basi Cop*, 2 lbs. Moderate early-season spray injury, resulting in loss of about 10 per cent of leaves. Remaining leaves showed browning on underside and were definitely off color. Good control of leaf spot; early spots burned out. Like some of the other materials, Basi Cop has definite promise if made safe as a fungicide.
3	*Oxo Bordeaux*, 3 lbs. Since this product was used at only half strength, the results are of little value in evaluating it. No injury, except a little browning on underside of leaf, was evident throughout the season. Disease spread slowly until after last spray was applied and then spread quite rapidly. At end of season about 35 per cent of leaves were off and most of those remaining showed infections. Further tests of this product at 6 lbs. per 100 gallons seem justified.
3	*Bordeaux mixture*, 4–6–100 This plot, unlike some of the other copper plots, showed no spray injury until about one month after harvest. From that time on, the injury became increasingly worse until, by the middle of September, over 70 per cent of the leaves were off. Excellent control of leaf spot was secured. Leaves were browned on underside and off color after injury began to appear.
1	*Liquid Lime Sulphur*, 2 gallons (Fig. 3, B) This was another of the best plots in the experiment. No injury was evident throughout the season. Very little browning on underside of leaves, which had excellent color all season long. A little leaf spot was evident in the plots about one month after harvest. It continued to develop until about 10 per cent of the leaves fell and at least 25 per cent more were infected.

were Bordeaux 34, used with zinc sulphate and lime; Cupro-K; and liquid lime sulphur.

Other materials that gave very good control of leaf spot, but must be made safe for use on cherries, were Copper Hydro 40; Coposil; Basi Cop, the special copper from the Niagara Sprayer and Chemical Company; and Cuprocide 54.

Since both Oxo Bordeaux and copper phosphate were used at weaker dilutions than recommended, further tests are necessary before commenting on them.

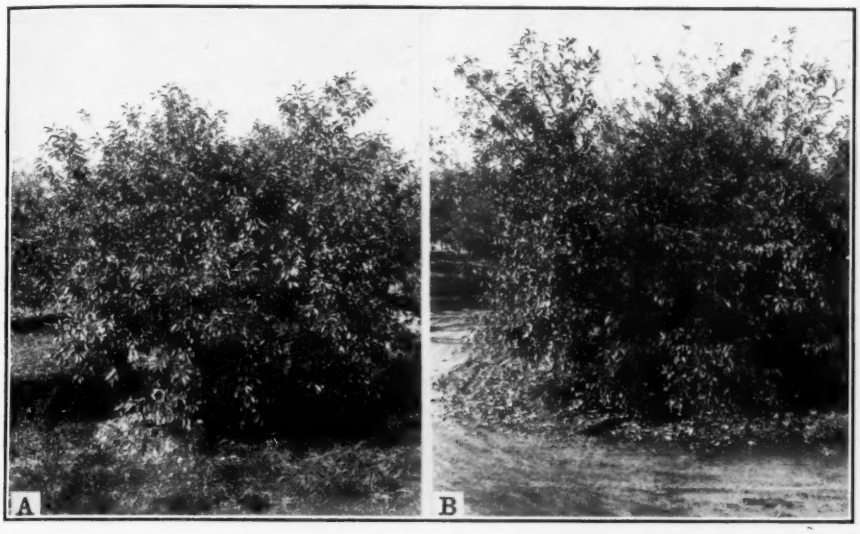

FIG. 3. A. Cupro-K, 2 lbs. per 100 gallons, was the spray used on this tree. It gave excellent control of leaf spot with only a little injury early in the season. The injury was of no commercial concern. B. Tree sprayed with liquid lime sulphur at the rate of 2 gallons per 100 gallons of water. This was a very good plot until about 4 to 5 weeks before frost, when leaf spot began to cause leaf fall. About 10 per cent of the leaves have fallen from this tree.

COMMENTS CONCERNING COPPER SPRAYS FOR APPLE SCAB CONTROL

Since our results concerning the use of the various copper sprays for the control of apple scab (*Venturia inaequalis*) will appear in the 1937 "Transactions of the Illinois State Horticultural Society," it does not seem desirable to give more than a brief summary of the findings at this time.

All of the new sprays tested, except 66a, gave satisfactory control of apple scab, but the copper sprays are not advised in the apple-scab schedule because of the injury they are likely to produce.

Certain sulphur sprays may be used effectively up to and including the first cover spray (1 week after calyx), without injury, even though oil is to be used in the third cover. Weather conditions, which occasionally justify second cover scab sprays, are essentially the same as those most likely to produce copper burn. Under experimental and commercial conditions several instances of severe fruit russet from one application of copper-spray materials in either the first or second cover sprays or from an application in each of them have come to our attention this season. This condition was observed on Jonathan, Winesap, Ben Davis, and Delicious. In another instance where Delicious was sprayed in the first and second covers with various copper sprays, no injury resulted from many of the materials used.

DISCUSSION

Although the results herein reported represent only one year's experiments, we present them, nevertheless, with the hope of contributing to the

present efforts of evaluating the various possible substitutes for Bordeaux mixture. Presentation of a single year's data is further justified by the fact that the 1937 season, in Illinois, was ideal for the development of apple blotch in the vicinity of Urbana, apple scab, and cherry leaf spot, and of spray injury from water-soluble chemicals.

Apple Blotch

All materials, except 66a, gave satisfactory control of apple blotch on fruit and leaves. Through a mistake, copper phosphate, lime, and bentonite were used in all of this year's tests at one-half recommended strength. In spite of this fact, there was good control of apple blotch on fruit and leaves, but, along with 66a, these materials did not control the disease satisfactorily on the petioles.

Both from the standpoint of blotch control and spray injury, the following materials were satisfactory this year (concentrations in 100 gallons): Bordeaux 34, 2 lbs., with zinc sulphate, $\frac{3}{4}$ lb., and lime, $\frac{3}{4}$ lb.; Oxo Bordeaux, 6 lbs.; Copper Zeolite, 3 lbs.; Copper Hydro 40, 3 lbs. Cupro-K is recommended for test at 3 lbs., since, at 4 lbs., it was at the border line of safety, causing a little speeking of the fruit.

Copper phosphate, 4 lbs., lime, 6 to 8 lbs., and bentonite, 4 lbs. seem to justify further consideration as a blotch spray, since, used at one-half the above concentration, it controlled all phases of blotch, except on the petioles, without any sign of injury to the tree or fruit.

The other materials that controlled blotch, but caused injury of commercial importance to either the fruit or leaves or both, are Cuprocide 54, Basi Cop, Bordeaux mixture, the special copper from the Niagara Sprayer and Chemical Company, and Coposil.

No data of significance were obtained this season on the combatability of the various materials tested with fixed nicotine, insofar as codling-moth control was concerned.

Cherry Leaf Spot

Most of the companies that furnished materials recommended smaller concentrations for the control of cherry leaf spot than for apple blotch. This, together with the fact that applications were made at greater intervals than in the blotch study, has caused some materials that gave excellent control of blotch to fall down in the control of cherry leaf spot. Whether or not their failure to control was a function of poor weathering or the dilution of the material was not determined.

In this study both copper phosphate and Oxo Bordeaux were used at one-half the recommended strength. Both sprays so used, as well as Copper Zeolite, failed to control leaf spot after the last sprays were applied, although they held the disease in check quite well until after harvest. 66a was of no value in cherry leaf-spot control. All other materials used controlled leaf spot but many of them caused rather serious spray injury.

From the standpoint of cherry leaf-spot control and spray injury, the following materials were satisfactory this year as recommended and used (concentrations in 100 gallons): Bordeaux 34, 1½ lbs., zinc sulphate, ½ lb., and lime, ½ lb.; Cupro-K, 2 lbs.; liquid lime sulphur, 2 gallons.

Other fungicides that have definite promise as cherry leaf-spot sprays, but that must be made safe before they are used, are Copper Hydro 40, Coposil, Basi Cop, and the special copper from the Niagara Sprayer and Chemical Company.

Apple Scab

It is doubtful if there is any place in the Illinois apple scab schedule for the use of copper fungicides, because of the injury they cause under Illinois climatic conditions. All of the materials tested, except 66a, gave satisfactory control of scab.

RÉSUMÉ

It seems safe to say that some of the new copper fungicides have definite promise as possible substitutes for Bordeaux mixture. Not many of them, however, are safe for fruit-tree spraying as now recommended. Some of the products that caused spray injury could undoubtedly be rendered safe without affecting materially their fungicidal values. A few of the products that appear to be quite safe as now recommended need further study to determine satisfactory concentrations for use against the various diseases.

UNIVERSITY OF DELAWARE, NEWARK, DEL., AND
UNIVERSITY OF ILLINOIS, URBANA, ILL.

THE SPREAD OF ONION MILDEW BY WIND-BORNE CONIDIA OF PERONOSPORA DESTRUCTOR

A. G. NEWHALL

(Accepted for publication January 31, 1938)

Since Cook's (2) discovery of the mycelium of *Peronospora destructor* within the seed of onion and Leach's (5) demonstration of seed transmission of the downy mildew of beet, the writer (12) has obtained circumstantial, though not positive, evidence of seed transmission in onions, which seemed to warrant extensive tests of seed treatment by hot water as a means of gaining further corroboratory evidence of Cook's theory.[1] Since the field evidence indicated that seed transmission might be comparatively rare (1 seed out of many thousands), the field tests with hot-water-treated seed have been extensive rather than intensive, involving treatment of nearly a ton of seed obtained from over 100 onion growers during the past 3 years.

During this period, mildew occurred on many of the farms where these tests were being conducted. On a few of them it appeared first in the plots sown with nontreated seed; on a very few, however, it appeared first in the plots sown with treated seed. In most cases no striking difference in time of appearance or severity of mildew could be observed. During the past sea-

[1] The treatments employed after laboratory tests of many samples, consisted of immersion in hot water at 51° C. for 22 to 25 minutes.

son, moreover, which was the only one of the 3 in which mildew reached epiphytotic proportions,[2] the behavior of the disease in certain experimental plots clearly indicated that there were some sources of primary inoculum other than that being investigated and that were fully as early and probably more important. These sources include the Egyptian or topset onions grown in backyard gardens, together with their related potato or multiplier onions, and the bulbs carried through the winter in storage by many growers who grow their own seed.

It has been known since the work of Murphy and M'Kay (9) and of Katterfeld (4) that *Peronospora destructor* lives over as perennial mycelium in such bulbs, but the importance of these sources of primary inoculum has been discounted in America for 3 reasons: The topset onions are not believed to be grown commonly enough to be a factor; they seldom if ever are grown close enough to commercial fields to be a menace; and the conidia of *P. destructor*, in common with other members of the Peronosporaceae, are thin-walled, delicate, easily desiccated, and are, therefore, considered incapable of surviving transportation by air to any distance. The data presented here are in disproof of these 3 suppositions.

FIRST CLUE TO AERIAL DISSEMINATION

The most striking piece of field evidence pointing to the importance of seed bulbs and topsets as sources of primary inoculum was obtained in a muckland valley devoted largely to onion and celery culture in Wayne County, where experimental plots were laid out comparing hot water and hot acetic acid treatments of suspected commercial seed with home-grown, mildew-free seed.

The spring and early summer of 1937 were unusually wet and foggy and very favorable for the development of mildew, which was first found on one or two garden plantings of topsets in Wayne County in mid-May. By the last week in June, mildew was found in all of the seed-treatment plots in the experimental acre referred to, but its occurrence was hardly what would have been expected had it been seed-borne. Individual primary infections were rather evenly scattered over the entire field, strongly indicating a distant source of inoculum. The plots from home-grown seed had as much disease as did those from treated commercial seed. The checks had no more, and, although the hot acetic acid plots showed fewer lesions, this could be accounted for by the fact that the seed treatment had greatly reduced the stand so that there were fewer leaves to the acre to arrest the falling conidia as they drifted through the air.[3] The counts and stands are given in table 1.

That the primary conidia did come through the air in this case was soon shown to be likely. By making counts of the number of blighted leaves per

[2] In 1937 the Northeastern States suffered one of the worst outbreaks of mildew on record, due largely to a very wet May and June.

[3] The treatment consisted of immersion in hot water at 50° C. for 25 minutes. The .5 per cent acetic acid bath was at the same temperature for 20 minutes.

TABLE 1. *Failure of onion mildew control by seed treatment as indicated by the distribution of primary infections on various plots. July 8, 1937*

Source and treatment	Stand of onions per 100 ft. of row	Lesions of mildew per 100 ft. of row
Home-grown Y.G. (disease-free)	1200	1.62
Brig. Y.G. (Check) (suspected)	1408	1.25
Brig. Y.G. (Hot water)	1361	1.60
Brig. Y.G. (Hot acetic)	735	.38

100 feet of row in all the fields in this valley, to the northwest, and to the south of the experimental plots, it was found that there was progressively more mildew as one moved from south to northwest. The lesions appeared to be of the same age until one reached the northwest corner of the valley, where, obviously, the source of inoculum was located. This area consisted

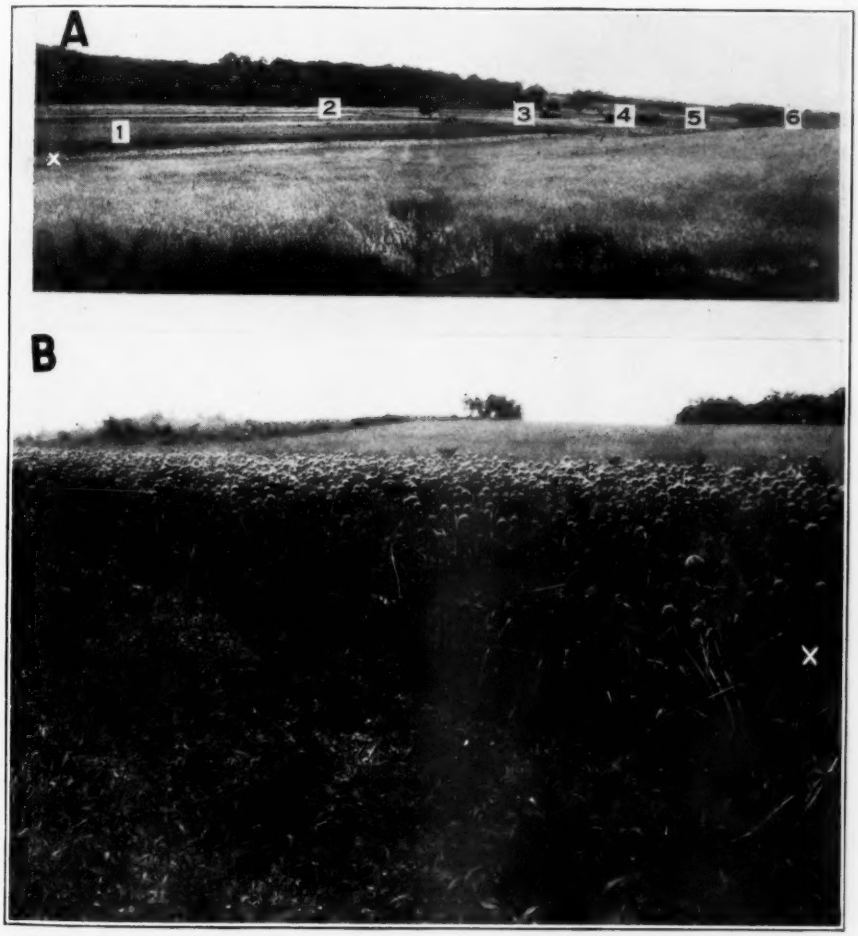

FIG. 1. A. General view of valley where onion-mildew seed-treatment tests were conducted, looking S.E. Source of primary infection (X) left center. Location of fields referred to in table 2, indicated by numbers 1 to 6. B. Near view of source of primary infection in onions being grown for seed (shown at X in A).

FIG. 2. A. A typical backyard, 15-foot row of badly blighted 3-year-old topset onions growing within ¼ mile of commercial fields in Wayne County. B. An exceptionally large planting of 6-year-old topsets badly diseased and within a mile of commercial onions in Wayne County.

of a $\frac{1}{16}$-acre plot of bulbs grown for seed. In one end of it mildew was far advanced. Conidia evidently had been produced here for several weeks (Fig. 1). Still farther up the hillside, a quarter of a mile northwest of these onions, there was a backyard planting of topsets in a similar advanced state of blight. This also had been shedding spores for several weeks (Fig. 2, A). Since the prevailing winds are from the northwest, they naturally

would carry inoculum in the direction of the commercial fields and distribute it in diminishing amounts as the distance increased. The counts of lesions and distances from the first-mentioned source are given in table 2.

TABLE 2. *Distribution of onion mildew in a valley 3300 feet long. July 8, 1937*

Field	Distance from primary source	Mildew lesions per 100 ft. of row
1	120 feet	1135
2	780 "	107
3	1750 "	4
4	2200 "	1.7
5	2800 "	1.0
6	3300 "	.33

To obtain an idea regarding the potential number of spores that a diseased backyard planting could produce, the following counts and computations were made. First, the number of spore-bearing tips of 63 conidiophores was counted under the microscope. The average number was found to be 16. The number of stomata per square inch of onion leaf surface was then calculated after a few counts and found to be approximately 65,000. If we then postulate 1 conidiophore growing out from but 1 of every 10 stomata, we have a total of over 100,000 conidia per square inch of leaf surface. It is, of course, common for the fungus to sporulate over several square inches of a plant at one time, so that a single small planting of a few dozen diseased onions can give rise to many millions of conidia overnight and can repeat this production many times in the spring. The writer has wiped a crop of conidiophores from a given leaf as many as 3 times, and each time a new crop formed within 48 hours.

THE EXTENT OF PERENNIAL ONION PLANTINGS IN ONE COUNTY

A survey was made of some 95 miles of county road across Wayne County, New York, the last week of June. A total of 497 farm properties were examined for backyard plantings of onions. Only 240 of these had vegetable gardens, but topsets were found in 17 of them, 8 of which were diseased. In most cases the diseased plantings were closer to the mucklands than were the healthy ones.[4]

Similarly, in the town of Marion, possessing approximately 175 home properties, most of which had backyard vegetable gardens, a survey in June showed that, out of 60 gardens examined, topset and multiplier onions were growing in 21 of them, and mildew was present in 17 of these 21. Here was a potential source of many millions of spores not over a mile or two from important commercial plantings. It is of interest to note that, in 1937, fields of onions to the west of Marion were much less injured than fields to the east. The prevailing winds are from the west, which fact may have a bearing on this.

[4] Almost all commercial onion culture in upstate New York is on muckland.

Besides the backyard plantings noted above, in Wayne County, over 50 others have been located on a few main roads in the western part of the State. Of these, 31 were diseased by July, 1937 (Fig. 2). If the ratio of perennial plantings per square mile holds for the entire State, there must be many hundreds if not thousands of these hidden sources of primary inoculum.

PROOF OF AERIAL DISSEMINATION OF CONIDIA

Two separate experiments were performed in midsummer to demonstrate that the conidia of this fungus were floating in the air and that they were viable. On July 15, a series of 37 stationary spore traps were mounted about 3 to 5 feet above ground on fence posts, in shrubs, and on lath supports in a pasture extending $\frac{1}{3}$ mile north of a severely infected field of onions. They were left overnight, during which time a trace of precipitation occurred, and a favorable 12-mile wind blew from the south. The next morning the 37 slides were collected and subsequent examination revealed the presence of conidia of *Peronospora* on 12 of them. The conidia were easily detected by their great size. Four of them were caught the maximum distance of $\frac{1}{3}$ mile from the nearest onions. There is no proof that any of these were viable when caught, but some indication was afforded by the fact that similar spores collected on leaves at 6 p.m., a few minutes after setting up the traps, were observed to germinate overnight. It is, therefore, likely that a certain proportion of those in the air were also viable. The day had been cloudy, misty, and altogether very favorable for sporulation.

To obtain further evidence on the aerial dissemination and viability of these conidia, on August 1 a flight was made by airplane over a heavily infected onion-growing area, known as the Montezuma Marshes, lying 50 miles north of Ithaca.[5] Plain agar Petri-dish spore traps, taken up in autoclaved sealed cans, were exposed for 4-minute periods at different elevations between 1500 and 50 feet (Fig. 3). The speed of the plane was held down to approximately 55 miles an hour, so that 9 square inches of agar surface in each trap had a chance to come in contact with approximately 1200 cu. ft. of air. Exposures were made between 9:25 and 10:05 a.m., with a temperature of 20° C., and relatively humidity of 85 per cent. A heavy fog, blanketing the ground all night, had induced abundant sporulation; and a light northwest wind rose to approximately 8 miles an hour by 10 a.m.

The traps were taken to the laboratory and incubated overnight at 15° C. before examination. The results of the flight and the subsequent spore germinations are given in table 3.

Conidia of the *Peronospora* in question were caught at all elevations from 1500 feet down. Although there was considerable thinning out above 700 feet, doubtless they could have been caught much above 1500 feet if sufficient search had been made in the right places. Probably the most significant

[5] The writer is indebted to Mr. H. M. Peters, manager of the Ithaca Flying Service, for his interest and aid in prosecuting these studies; to Mr. Jack Hoffman, the pilot; and to Mr. F. C. Meier of the U. S. Department of Agriculture for the loan of some of the "skyhook" equipment used by Col. Lindbergh in 1933.

FIG. 3. Petri-dish spore traps and wooden holders (foreground) used in airplane flight over onion fields. Note parallel lines ruled on bottom of dish to facilitate microscopic examination later. The dishes in sealed cans were removed as needed through a slit near the bottom of the vertical cans in the background.

TABLE 3. *Results of airplane spore-trap exposures made August 1 to catch conidia of Peronospora destructor. Savannah, New York, Aug. 1, 1937*

Trap No.	Elevation in feet	Total conidia of *Peronospora* caught	Number germinating	No. cu. ft. of air per spore[a]
1	1500	7	6	171
2	1200	1	1	1200
3	1200	3	2	400
4	700	1	1	1200
5	700	13	11	93
6	700	11	5	109
7	200	30	30	40
8	100	26	15	46
9	50	37	26	32
10	[b]	3	3	400
11	2000[c]	0	0	0
	Total	132	100	

[a] Calculated by assuming each trap acted as a filter to extract the spores from 302 cu. ft. of air per minute. If the spores had been as large as hen's eggs, they would have blotted out the sun and have made flying through them too dangerous to attempt.

[b] Exposed on leaving the field and climbing to 1000 feet.

[c] Exposed over end of Cayuga Lake 5 to 10 miles from field.

fact was that 100 of the 132 conidia caught promptly germinated on the agar during the next few hours. This seems to be the first report of viable conidia of one of the Peronosporales being secured from even these low elevations.

In addition to the conidia of *Peronospora*, many other spores were in the air, as found by several others, who have captured spores in similar manner, viz., Stakman, *et al.* (11), Meier, Stevenson, and Charles (8), and Meier and Lindbergh (7). Spores of *Macrosporium* or *Alternaria* spores were the most abundant. Urediospores of rusts, pollen grains, and conidia of *Helminthosporium*, smuts, and various molds, such as *Penicillium* and *Aspergillus*, also were obtained.

An attempt was made to infect several potted onion plants by inoculation with germinated conidia transferred from the agar spore traps, but without success. Even the control plants inoculated with a fresh spore suspension failed to develop mildew, probably because of the exceptionally hot weather that prevailed during the two weeks immediately following inoculation.

LONGEVITY OF CONIDIA UNDER CONTROLLED TEMPERATURE AND HUMIDITY CONDITIONS

The question of the length of time *Peronospora* conidia can remain viable in the air under a variety of temperature and humidity conditions has an important bearing on the general question of aerial dissemination of the conidia and the need for eradication of perennial onions. Earlier investigators (2, 13) in this country have emphasized the short life of these spores, indicating it to be only a few hours at most, although Angell and Hill (1) state that in one test in Australia 2 per cent of the conidia remained viable on glass slides out of doors for 24 hours, and, in Russia, Katterfeld (4) states that he kept some alive for 10 days in a moist atmosphere.

The method of MacLachlan (6) was used employing Kolle culture chambers with sulphuric acid solutions in them to maintain the spores at 6 different relative humidities between 50 per cent and 100 per cent, inclusive. Spores were collected from topset onions in the writer's garden, in the morning, and brought to the laboratory on ice while still moist with dew. They were transferred to glass slides, then were placed in the Kolle flasks and held at different constant temperatures for varying periods of time, up to 5 days, when the slides were removed, drops of water placed on them and incubated for at least 12 hours at 12° C. The results of these spore germination tests showed the conidia capable of remaining viable longer and at lower humidities than were expected. It is regrettable that the experiments were stopped by cold weather, which cut off the supply of conidia before final results could be obtained, but a summary of the data, as far as they go, is presented in table 4, which shows that some spores were able to survive for several days at humidities above 70 per cent and ordinary temperatures, such as prevail in the spring for many days at a time (Fig. 4).

As it was never possible to obtain spores enough from any one lesion for an entire series of slides, it is not surprising that considerable variability in viability was encountered. Spores of *Peronospora tabacina* from different lesions and from leaves of different ages have also been found by Angell and Hill (1) to lack uniformity in vitality.

EFFECT OF SUNSHINE ON VIABILITY OF CONIDIA

Sunshine has been considered by some to be deadly to the conidia of *Peronospora*, but it seems that when the factors of temperature and humidity are favorable, the spores can withstand an exposure of several hours to bright sunshine. This was determined by exposing drops of spore suspensions on glass slides to the direct rays of the sun on the laboratory window-

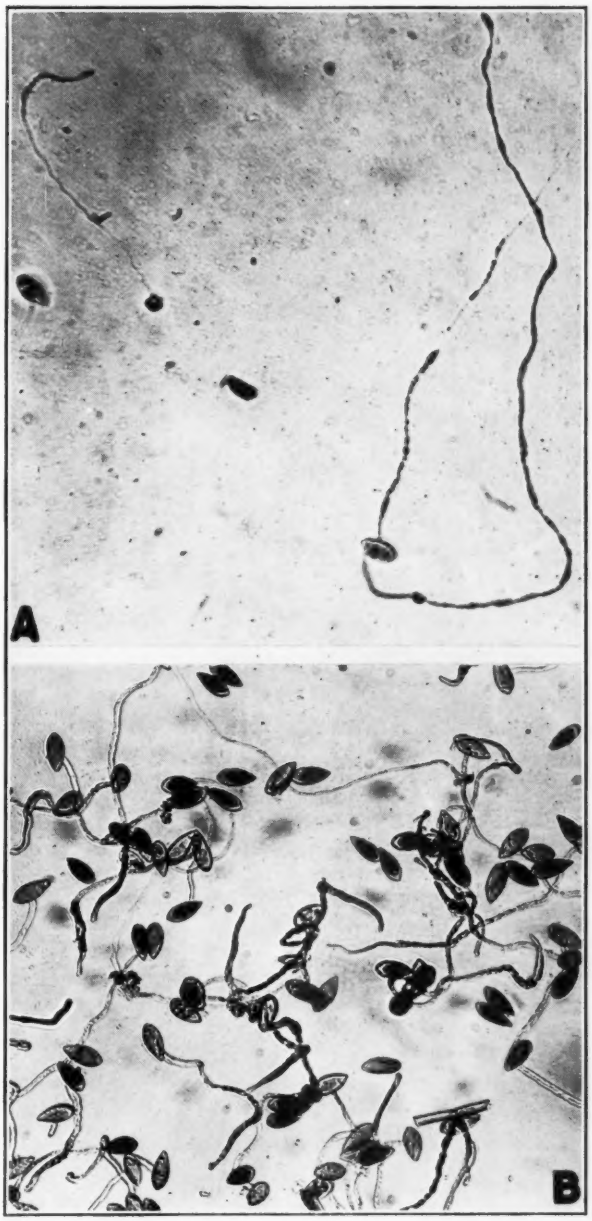

FIG. 4. A. Germination of conidia of *P. destructor* caught on plain agar 1500 feet above an onion field August 1, 1937. The germ tube of the one on extreme left is not in focus. ×85. B. Conidia germinating 48 per cent after 60 hours exposure to air at 70 per cent relative humidity, in the dark, at 15° C. ×85.

sill. Preliminary tests indicated that exposures up to 2 hours were harmless. On September 25, which was an exceptionally clear, bright day, a 7-hour exposure was made. To insure a favorable temperature, the slides were placed on an aluminum tray of ice cubes. The temperature of the

TABLE 4.—*Viability of Peronospora destructor conidia after exposure to various temperature and humidity conditions*[a]

Exposure period	Relative humidity						Exposure period	Relative humidity					
	100 %	90 %	80 %	70 %	60 %	50 %		100 %	90 %	80 %	70 %	60 %	50 %
	9° C.							15° C.					
48 hrs.	36.0	78.0	68.0	11.0	tr.	0	4 hrs.	72.0	48.6	37.3	22.0	32.6	2.0
84 "	83.0	75.0	56.0	23.0	3.0	0	14 "	82.6	67.8	37.0	23.0	tr.	0.0
120 "	30.0	23.0	29.0	0.5	0.0	0	30 "	76.8	81.0	85.2	80.0	11.4	0.0
							60 "	71.0	90.6	77.4	47.8	1.1	.....
							72 "	81.6	41.2	38.8	2.2	tr.	tr.
							84 "	54.0	40.0	31.6	5.0	0.2	0.0
	21° C.							27° C.					
6 hrs.	97.0	79.6	64.8	48.2	1.2	tr.	12 "	48.0	48.6	37.0	3.4	0.8	.....
12 "	86.2	.....	53.4	.....	13.0	.....	24 "	47.0	13.4	2.1	tr.	tr.	.....
24 "	6.8	82.8	12.6	5.8	0.3	.....							
48 "	9.4	6.0	2.0	0.0	0.8	.....							
60 "	18.0	5.0	tr.	4.2	0.0	.....							

[a] Percentage germination figures in the body of the table are means of 5 counts of 100 spores each.

air in the bright sun ranged between 21° and 24.5° C., but the temperature of the slides remained between 13° and 20° C. Control slides were maintained just inside the window in the shade. The drops of water had to be renewed about every 30 to 60 minutes to take care of evaporation. Germination counts (Table 5) were made the next day after an incubation period overnight at 12° C.

These tests simply indicate that sunshine, in itself, is not lethal to conidia of *Peronospora* if they do not become dried or too warm. Katterfeld (4) reported that *P. destructor* conidia did not survive 2 hours' exposure to sun in a dry atmosphere, but Angell and Hill (1) obtained slight germination after 24 hours' exposure on a glass slide, part of which time was said to have been spent in direct sunlight.

TABLE 5.—*Germination of conidia of Peronospora destructor after exposure to sunshine in drops of water*

Exposure	Mean germination	
	In shade	In sunshine
	Per cent	*Per cent*
Checks—in incubator directly	76.0	
1 hour	85.4	78.0
2 hours		63.8
3 "	69.0	75.0
4 "		78.0
6 "		27.3
7 "	72.6	6.9

EFFECT OF LOW TEMPERATURES

Freezing the conidia of *Peronospora destructor* was found to lower the germination but not to destroy it entirely. After 12 or 15 hours in a block of ice, approximately 12 per cent germination was obtained in one trial. In this connection, Patel (10) reported germination of *P. trifoliorum* after 173 hours in a frozen condition, and Leach (5) found that not only were conidia of *P. schachtii* unaffected by short periods of freezing but that a few were capable of germinating after 40 days at –12° C.

VIABILITY IN DILUTE COPPER SOLUTIONS

It has always been thought that copper sulphate was extremely toxic to the spores of the Peronosporales, but McWhorter and Pryor[6] have pointed out that malachite green is much more so. The writer, too, found it almost twice as toxic as copper sulphate. The dye (light green N) completely inhibited germination at dilutions up to 1–150,000, while copper sulphate permitted germination at dilutions greater than 1–75,000.

Whether control by spraying will ever be successful, even with better fungicides, is still a question and beyond the scope of the present work. Several years ago great efforts were made to hold the disease in check in New

[6] McWhorter, F. P., and J. Pryor. Onion mildew in Oregon and the advisability of testing malachite green as a control agent for downy mildews. U. S. Dept. Agr., Bur. Plant Indus. Plant Disease Reptr. 21: 306–307. 1937. [Mimeographed.]

York with Bordeaux mixture and copper-lime dust applied thoroughly and frequently, but with no success whatsoever.

DISCUSSION

Without reference to the possible transmission of onion mildew through the seed, which may or may not take place, it seems to the writer that further progress on that phase of the problem must now await the solution of a more pressing problem of eradicating the disease early in the spring by destruction of the many perennial sources of primary inoculum that exist as diseased backyard plantings of perennial topset and multiplier onions. There are far more of these plantings in the East than have been suspected. Some plantings have been in for over 40 years. They are on the increase, and there is reason to believe that a very large proportion (over one-half) of them in the commercial onion-growing counties are diseased.

It has been shown that the conidia of *Peronospora destructor* can be recovered from the air several hundred feet off the ground in a viable condition and that the spores are well able to remain viable for several days at temperatures and humidities that often prevail in the spring for many days in the Northeastern States. Thus, all the necessary conditions for successful aerial dissemination seem to be met.

In this connection, Doran (3) pointed out that the spread of downy mildew of cucurbits into the New England States is most logically explained on the assumption that winds and rain bring the conidia of *Peronoplasmopara cubensis* up the coastal States from Florida. Similarly, Leach (5) presents evidence to indicate that the spread of downy mildew of beet in California takes place over restricted areas by means of wind-borne conidia. The writer has been informed that there is good circumstantial evidence that *Peronospora tabacina* on tobacco is carried up with winds accompanying rainy periods from certain sources of primary infection in Florida into Georgia and the Carolinas. If the fungi causing these are wind-borne, then those causing late blight of potato and several other downy mildews may also be, to a considerable extent.

How far from commercial plantings it will be necessary to eradicate perennial onions to safeguard the commercial crop is still another problem; but, from the work on rusts of apple and white pine, one might think 3 to 5 miles would be sufficient in most seasons. As others have pointed out, however, there is no secondary spread in the case of the two rusts mentioned, while such infections are very common and important in the case of the mildews. On theoretical grounds, a field 2 miles distant from a given source of primary inoculum should be 4 times as safe as a field 1 mile distant, but this is true only when spores are evenly distributed in all directions.

The problem of overwintering in regular onion sets and in bulbs to be used for growing seed is still a very important one. But it can probably best be solved through bulb treatment after the manner described by Murphy and M'Kay (9). Work along this line is in progress; but, even if successful, the results may be more or less nullified unless the backyard plantings of diseased perennial onions are eradicated, at least in the im-

portant commercial onion districts of the North. We have been able to confirm Murphy and M'Kay's discovery of the mycelium of *Peronospora destructor* in the bulbs of topset onions and expect to report on bulb-treatment experiments in the near future.

SUMMARY

Conidia of *Peronospora destructor* were caught in the air over diseased onion fields to a height of 1500 feet. Of 132 trapped on one flight of 40 minutes, 100, or 75 per cent, germinated.

Conidia have been found to survive freezing, exposure of 7 hours to bright sunshine in drops of water, and many days' exposure (at least 5) to air in the dark at a temperature of 9° C. and a relative humidity above 70 per cent.

Perennial topset and multiplier onions have been found commonly growing in backyard gardens on farms and in the small towns of agricultural counties. A large proportion of these were found to be diseased in June. Mycelium has been found in bulbs in November.

The conclusion is drawn that in some seasons, at least, these diseased perennial onions are a distinct menace to the $2,000,000 commercial crop of onions grown in New York State, because mildew is evidently a wind-borne disease.

Malachite green was found much more toxic than copper sulphate to the conidia.

CORNELL UNIVERSITY,
ITHACA, NEW YORK.

LITERATURE CITED

1. ANGELL, H. R., and A. V. HILL. The longevity of the conidia of certain fungi (Peronosporales) under dry conditions. Jour. Council. Sci. and Indus. Res. [Australia] **4**: 178–181. 1931.
2. COOK, H. T. Studies on the downy mildew of onions and the causal organism, *Peronospora destructor* (Berk.) Caspary. [New York] Cornell Agr. Expt. Sta. Mem. 143. 1932.
3. DORAN, W. L. Downy mildew of cucumbers. Massachusetts Agr. Expt. Sta. Bull. 283. 1932.
4. KATTERFELD, N. O. Zur Biologie der *Peronospora schleideni* Ung. Bolezni Rast. (Morbi Plant.) **15**: 71–87. 1926. [In Russian, German résumé. pp. 86–87.] [Abstract in Rev. Appl. Mycol. **7**: 216–217. 1928.]
5. LEACH, L. D. Downy mildew of the beet, caused by *Peronospora schachtii* Fckl. Hildgardia [California Sta.] **6**: 203–251. 1931.
6. MACLACHLAN, J. D. The dispersal of viable basidiospores of the Gymnosporangium rusts. Jour. Arnold Arboretum **16**: 411–422. 1935.
7. MEIER, F. C., and C. A. LINDBERGH. Collecting microorganisms from the arctic atmosphere. Sci. Mo. **40**: 5–20. 1935.
8. ———, J. A. STEVENSON, and VERA K. CHARLES. Spores in the upper air. (Abstract) Phytopath. **23**: 23. 1933.
9. MURPHY, P. A., and R. M'KAY. The downy mildew of onions (*Peronospora schleideni*), with particular reference to the hibernation of the parasite. Roy. Dublin Soc. Sci. Proc. n.s. **18**: 237–261. 1926.
10. PATEL, M. K. Study of *Peronospora trifoliorum* de Bary on species of Leguminosae. (Abstract) Phytopath. **16**: 72. 1926.
11. STAKMAN, E. C., A. W. HENRY, G. C. CURRAN, and W. N. CHRISTOPHER. Spores in the upper air. Jour. Agr. Res. [U. S.] **24**: 599–606. 1923.
12. STUART, W. W., and A. G. NEWHALL. Further evidence of the seed-borne nature of *Peronospora destructor*. (Abstract) Phytopath. **25**: 35. 1935.
13. WHETZEL, H. H. Onion blight. [New York] Cornell Agr. Expt. Sta. Bull. 218. 1904.

A MOSAIC-RESISTANT SMALL RED BEAN[1]

DONALD M. MURPHY AND W. H. PIERCE[2]

(Accepted for publication January 20, 1938)

INTRODUCTION

The common bean mosaic disease is very destructive to the small red or Red Mexican variety of beans in southern Idaho. Because of its resistance to curly top, the Red Mexican variety of beans constitutes an important part of the bean crop grown in Twin Falls and adjacent counties in local areas where the beet leaf hopper, *Eutettix tenellus* Baker, is prevalent. According to a mimeographed report of the United States Department of Agriculture,[3] Idaho produced 250,000, 100-pound bags of small red beans in 1935 and 164,000 in 1936. The total small red-bean production in the United States was 292,000, 100-pound bags in 1935 and 190,000 in 1936. Common bean mosaic has been recognized for many years and has been the subject of study by several workers. Pierce[4] described several properties of the common bean mosaic virus (*bean virus 1*) and reported yellow bean mosaic virus (*bean virus 2*). Common bean mosaic is a seed-borne disease that may be transmitted in the field to susceptible plants by several species of aphids. Important pathological effects of this disease on the Red Mexican variety include mottling and curling of leaves, dwarfing of the plant with a reduction in the yield and delayed maturity of the crop. The Red Mexican bean is very susceptible to this disease, and Idaho growers experience severe losses every year.

Both public and private agencies have been interested in the development of bean varieties tolerant or resistant to, the common bean mosaic disease. The Robust variety was introduced by the Michigan station in 1913 and was later shown by Reddick and Stewart[5] to be resistant to common bean mosaic. In 1934 Pierce and Walker[6] introduced 2 mosaic-resistant Refugee beans—Idaho Refugee and Wisconsin Refugee. The United States Department of Agriculture has developed U. S. No. 1, a garden variety tolerant to common bean mosaic, and U. S. No. 5, a Refugee type garden bean, resistant to common bean mosaic. The Plant Pathology Department of the University of Idaho has for several years conducted a breeding program for mosaic resistance in various varieties of beans and has developed and introduced 4 strains of Great Northern beans resistant to the common mosaic disease.

[1] Published with the approval of the Director of the Idaho Agricultural Experiment Station as Research Paper No. 162.

[2] W. H. Pierce was formerly Associate Plant Pathologist of the Idaho Agricultural Experiment Station. The writers wish to express their deep appreciation to Dr. C. W. Hungerford for his helpful suggestions throughout the course of this investigation and for aid in the preparation of the manuscript.

[3] United States Department of Agriculture, Bureau of Agricultural Economics. Production of beans in the United States, by commercial classes 1919–1936. 10 pp. Jan., 1937. [Mimeographed.]

[4] Pierce, W. H. Viroses of the bean. Phytopath. **24**: 87–115. 1934.

[5] Reddick, D., and V. B. Stewart. Varieties of beans susceptible to mosaic. Phytopath. **8**: 530–534. 1918.

[6] Pierce, W. H., and J. C. Walker. The development of mosaic-resistant Refugee beans. Canner **77**(26): 7–9. 1933.

The first to be developed was Great Northern U.I. 1, which was followed by U.I. 81, U.I. 59, and U.I. 123. The three strains, U.I. 81, U.I. 59, and U.I. 123, have replaced common Great Northern and U.I. 1 in commercial production, and now constitute almost the entire crop of Great Northern beans grown in Idaho. This paper deals with the development and introduction to the Idaho growers of a common-bean-mosaic-resistant Red Mexican variety.

MATERIALS AND METHODS

Throughout the program for the development of bean varieties resistant to common bean mosaic, extensive field trials were conducted in southern Idaho. The field trial plots were located near Buhl, where curly top was severe, and near Twin Falls, where the mosaic disease was severe. Several field selections were made in the Great Northern variety and from these selections strains of mosaic-resistant Great Northern beans were developed. Field selections in the Red Mexican variety failed to produce a resistant type; therefore, the mosaic-susceptible Red Mexican was crossed with a mosaic-resistant parent.

In 1929 several crosses and reciprocal crosses of Red Mexican and mosaic-resistant Great Northern U.I. 1 were made. The purpose of this particular cross was twofold: first, to aid in the development of a Red Mexican variety resistant to common bean mosaic; second, to aid in the development of a Great Northern variety resistant to curly top.

Since 1929 a continuous program of plant selection and testing in field trial plots was conducted with the material from the Red Mexican-Great Northern cross. Data were obtained on plant types, curly-top and mosaic-disease resistance of a large number of selections. Two selections, No. 3 and No. 34, proved most valuable from several standpoints. These two selections were increased until a substantial amount of seed was ready for distribution to the bean growers of southern Idaho.

YIELD AND QUALITY OF RESISTANT SELECTIONS

Throughout the program for the development of a Red Mexican variety resistant to common bean mosaic, an effort was made to obtain those selections that were of value because of their yield and their vine and seed characteristics. Two selections, No. 3 and No. 34, are very similar in seed size to the Red Mexican parent, and this small size of seed seems to be a characteristic demanded by the trade. The seed-coat color of selections No. 3 and No. 34 is darker red than the Red Mexican, a deviation in color thought to be an improvement of the Red Mexican variety. Soaking and cooking tests were made with the new selections and the Red Mexican parent, and it was found that the new selections retained more red color after soaking than did the parent types. Cooking tests showed that the new selections were of equal quality to the Red Mexican variety.

Vine and leaf characters of the new selections are very similar to each other and, in general, very similar to the Red Mexican parent, although Red

Mexican plants have foliage of a darker shade of green than that of the new selections. In comparing the two selections it was observed that selection No. 3 is of a slightly heavier vine structure and is somewhat darker green in color than No. 34. On limited field-plot tests the mosaic-resistant selections have consistently produced a higher yield than the Red Mexican parent. In table 1 are presented yield data obtained in 1936 and 1937, together with disease data of the two selections and the Red Mexican variety. In the new mosaic-resistant Red Mexican variety the inherent curly-top resistance of the Red Mexican variety has been retained with the mosaic resistance obtained from Great Northern U.I. 1.

TABLE 1.—*Data on yield and disease counts of two mosaic-resistant hybrid selections and Red Mexican beans*

Selection	Stand 50′ row		Common mosaic		Curly top		Yield of 50′ of 4 rows		Average yield
	1936	1937	1936	1937	1936	1937	1936	1937	
			Per cent	*Per cent*	*Per cent*	*Per cent*	*Lbs.*	*Lbs.*	*Lbs.*
U.I. 3	129	131	0	0	0	0	29.5	35.7	32.6
U.I. 34	103	164	0	0	0	0	31.3	35.3	33.3
Red Mexican	202	168	70[a]	90[a]	0	0	18.8	29.0	23.9

[a] Estimated infection.

It should be stated that neither Red Mexican, Great Northern U.I. 1, nor the two new hybrid selections are resistant to yellow bean mosaic (*bean virus 2*). Yellow bean mosaic and common bean mosaic can easily be confused in the initial stages of development under field conditions. Yellow bean mosaic is not seed-borne and is of only minor importance in the commercial production of small red beans in Idaho.

PLANS FOR RELEASE

It is sometimes a difficult problem in commercial bean production to keep a variety pure. Growers will no doubt find this to be true, as the new strains were distributed in a bean-growing section where large plantings of small red beans have been produced for several years. While the new strains were being grown in the increase plots, they were inspected by the State Seed Inspector in the regular manner. Later, after passing further tests, they were certified and sealed. The new strains were distributed to selected growers through the cooperation of the Idaho county extension agents. Growers will be encouraged to meet the high standard of the State inspection service with the hope that a large seed supply can be obtained free from varietal mixture.

NAMES OF THE RESISTANT SELECTIONS

The two new common-bean-mosaic-resistant selections have been named Red Mexican U.I. 3 and Red Mexican U.I. 34. The numbers, in each case,

represent the nursery number of each selection. Red Mexican will designate the variety and distinguish the new small red beans from other varieties developed by the University of Idaho. This method of naming follows the one used with the Great Northern varieties resistant to common bean mosaic.

DEPARTMENT OF PLANT PATHOLOGY,
UNIVERSITY OF IDAHO,
MOSCOW, IDAHO

FURTHER DETERMINATIONS OF THE CARBOHYDRATE-NITROGEN RELATIONSHIP AND CAROTENE IN LEAF-HOPPER–YELLOWED AND GREEN ALFALFA[1]

HOWARD W. JOHNSON[2]

(Accepted for publication February 5, 1938)

INTRODUCTION

In an earlier paper[3] the writer reported that alfalfa leaves yellowed by the potato leaf hopper, *Empoasca fabae* (Harris), are lower in nitrogen and higher in carbohydrates than green alfalfa leaves. The samples for the analytical work upon which this conclusion was based were produced in infested and noninfested cages of cheesecloth or tobacco cloth. More recently[4] he has reported that alfalfa yellowed by natural infestation with leaf hoppers is much lower in carotene, and, hence, in potential vitamin A activity, than green alfalfa kept free from leaf hoppers by dusting with a mixture of 300-mesh sulphur and pyrethrum. A third possible method of producing samples of leaf-hopper-yellowed and green alfalfa for comparative analysis would be to cage a portion of a plot after the first cutting was made and allow the remainder of the plot to be subject to natural infestation with leaf hoppers. In this setup, the cage used to protect a portion of the alfalfa from infestation might be considered as taking the place of the protective dust used in method 2. It seemed desirable to determine if these different methods of producing leaf-hopper-yellowed and green alfalfa would yield samples of comparable chemical composition insofar as the carbohydrate-nitrogen relationship and carotene content were concerned.

[1] This paper reports the results of one phase of a cooperative study of the injury by *Empoasca fabae* (Harris) to forage legumes being made at Arlington Experiment Farm, Arlington, Va., by the Division of Cereal and Forage Insect Investigations, Bureau of Entomology and Plant Quarantine and the Division of Forage Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture.

[2] Indebtedness is acknowledged to J. G. Conti, formerly Junior Biochemist, Bureau of Plant Industry, for assistance with the carbohydrate and nitrogen determinations and to C. A. Cary and H. G. Wiseman, Bureau of Dairy Industry, U. S. Department of Agriculture, for making the carotene determinations on samples submitted by the writer.

[3] Johnson, H. W. Nature of injury to forage legumes by the potato leaf hopper. Jour. Agr. Res. [U. S.] **49**: 379–406. 1934.

[4] Johnson, H. W. Effect of leaf-hopper yellowing upon the carotene content of alfalfa. Phytopath. **26**: 1061–1063. 1936.

EXPERIMENTAL METHODS AND RESULTS

In July, 1932, samples of leaf-hopper-yellowed and green Peruvian alfalfa leaves were harvested from noncaged plants and from plants in a noninfested cheesecloth cage and were preserved in alcohol for analysis. In August, 1932, similar samples were harvested from an infested and a noninfested cage in the same plot of Peruvian alfalfa as above. In July, 1935, samples were harvested from nondusted Grimm and Kansas alfalfa

FIG. 1. Shoots of leaf-hopper-yellowed Grimm alfalfa (left) from a nondusted plot compared with shoots of green Grimm alfalfa (right) from a plot kept relatively free from leaf hoppers by dusting with a mixture of 300-mesh sulphur and pyrethrum. Samples for chemical analysis were produced in this way for comparison with samples produced in infested and noninfested cheesecloth cages.

plots in which the alfalfa was heavily infested with leaf-hoppers, stunted, and badly yellowed, as shown in figure 1, and from adjacent dusted plots of the same varieties in which the alfalfa was green and relatively free from leaf hoppers. All of these samples subsequently were analyzed for carbohydrates and nitrogen by the methods reported in the earlier paper.[5] The results of these analyses are presented in table 1. These data show that the leaf-hopper-yellowed alfalfa leaves, whether from infested cages or cage-free and nondusted plots subject to natural infestation, are higher in dry matter,

[5] See footnote 3.

TABLE 1. *The carbohydrate-nitrogen relationship in leaves of alfalfa plants yellowed by natural infestation with leaf hoppers and by artificial infestation in a cheesecloth cage compared with the relationship in leaves of green alfalfa plants kept free from leaf hoppers by cheesecloth cages and by dusting with a mixture of 300-mesh sulphur and pyrethrum, Arlington Experiment Farm, Arlington, Virginia, 1932–1935. Results are presented for duplicate samples in all cases, except the noncaged rows in 1932. All carbohydrates are reported as dextrose and the percentages given for these are averages of duplicate determinations on each sample*

Plant material	Source	Dry matter	Green weight			
			Reducing sugar	Total sugar	Total acid-hydrolyzable	Total nitrogen
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Peruvian alfalfa leaves July, 1932	Noninfested cage	27.27	0.19	0.76	4.07	1.00
		24.37	0.18	0.62	2.46	0.97
	Noncaged rows	37.81	0.90	1.95	8.71	0.90
Peruvian alfalfa leaves Aug., 1932	Noninfested cage	25.92	0.19	0.66	3.11	1.18
		26.16	0.22	0.72	3.29	1.20
	Infested cage	37.20	1.20	2.65	10.60	1.05
		39.70	1.35	2.64	11.01	1.14
Grimm alfalfa leaves July, 1935	Dusted plot	29.00	0.24	0.80	3.29	1.12
		28.90	0.28	0.79	2.92	1.10
	Nondusted plot	36.73	1.05	1.87	9.31	1.03
		37.71	1.11	1.87	9.17	1.04
Kansas alfalfa leaves July, 1935	Dusted plot	28.40	0.23	0.71	3.77	1.10
		28.60	0.25	0.73	4.12	1.10
	Nondusted plot	36.75	0.98	1.82	9.62	1.02
		37.97	0.99	1.80	9.64	1.02

reducing sugar, total sugar, and total acid-hydrolyzable substances than are green alfalfa leaves from noninfested cages or dusted plots. On the other hand, the yellowed alfalfa leaves are lower in total nitrogen in all cases than are the green ones. The constancy of these differences in all the pairs of samples and their agreement with previous analyses of yellowed and green alfalfa leaves,[6] indicate that either caging certain plants or protecting them by means of sulphur-pyrethrum dust is a satisfactory method of producing samples free from leaf-hopper injury for a determination of the chemical differences between noninjured material and alfalfa subject to natural infestation with leaf hoppers or produced in artificially infested cages.

Samples of the stems of plants from the nondusted and dusted plots of Grimm and Kansas Common alfalfa also were preserved in alcohol and analyzed for carbohydrates and nitrogen at the same time as were the leaf samples. The results of these analyses are presented in table 2. These data show that the stems of leaf-hopper-yellowed alfalfa plants (nondusted) are lower in dry matter, reducing sugar, total sugar and total acid-hydrolyzable substances than are the stems of green alfalfa plants from dusted plots. On

[6] See footnote 3.

TABLE 2. *The carbohydrate-nitrogen relationship in stems of alfalfa plants yellowed by natural infestation with leaf hoppers compared with the relationship in stems of green alfalfa plants kept free from leaf hoppers by dusting with a mixture of 300-mesh sulphur and pyrethrum, Arlington Experiment Farm, Arlington, Virginia, 1935. Results are presented for duplicate samples in all cases. All carbohydrates are reported as dextrose and the percentages given for these are averages of duplicate determinations on each sample*

Plant material	Source	Dry matter	Green weight			
			Reducing sugar	Total sugar	Total acid-hydrolyzable	Total nitrogen
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Grimm alfalfa stems July, 1935	Dusted plot	34.06	0.31	0.98	6.75	0.66
		34.33	0.28	0.96	7.02	0.67
	Nondusted plot	33.05	0.17	0.62	6.73	0.76
		33.42	0.16	0.55	6.53	0.74
Kansas alfalfa stems July, 1935	Dusted plot	34.85	0.26	0.97	6.88	0.61
		35.08	0.26	1.04	7.18	0.60
	Nondusted plot	34.06	0.22	0.73	6.59	0.80
		34.27	0.19	0.67	7.02	0.75

the other hand, the yellowed stems are higher in total nitrogen than the green alfalfa stems.

It is evident from a comparison of the data presented in tables 1 and 2 that the carbohydrate-nitrogen relationship in yellowed and green alfalfa leaves is just the reverse of that existing in yellowed and green alfalfa stems. The yellowed leaves are higher in carbohydrates and lower in nitrogen than are the green leaves, whereas the yellowed stems are lower in carbohydrates and higher in nitrogen than the green stems. The work of Granovsky[7] and of Smith and Poos[8] showed that the potato leaf hopper feeds upon the vascular tissues of its leguminous hosts and causes a clogging of the food-conducting elements. One would expect such injury to retard the translocation of elaborated food from the leaves back into the stems and to result in a congestion of carbohydrates in the leaves and a deficiency of these substances in the stems. The analyses presented show that this condition exists in the case of leaf-hopper-yellowed alfalfa.

Samples of noncaged second-cutting Grimm alfalfa that had yellowed badly and of green alfalfa from a caged area in the same small plot were preserved in a freezing mixture of absolute alcohol and solid carbon dioxide on July 15, 1937, and were taken the following day to the Nutrition Laboratory, Bureau of Dairy Industry, for determinations of the carotene content. The determinations, which were made spectrophotometrically, show that the green alfalfa contains 227 milligrams of carotene per kilogram of dry matter, whereas the yellowed alfalfa contains only 71 milligrams. The dry

[7] Granovsky, A. A. Differentiation of symptoms and effect of leaf hopper feeding on histology of alfalfa leaves. (Abstract) Phytopath. **20:** 121. 1930.

[8] Smith, F. F., and F. W. Poos. The feeding habits of some leaf hoppers of the genus *Empoasca*. Jour. Agr. Res. [U. S.] **43:** 267–285. 1931.

matter content of the two types of material was determined to be 26.62 per cent for the green alfalfa and 35.58 per cent for the noncaged, yellow alfalfa. These results confirm the analyses presented in a previous paper,[9] which were based upon samples of yellowed alfalfa from nondusted plots and of green alfalfa from dusted plots. It would appear, therefore, that in the case of carotene determinations either caging certain plants or protecting them by means of sulphur-pyrethrum dust is a satisfactory method of producing samples free from leaf-hopper injury for comparison with samples of alfalfa exposed to natural infestation with leaf hoppers.

SUMMARY

Leaf-hopper-yellowed alfalfa leaves, whether from infested cages or cage-free, nondusted plots, are higher in dry matter, reducing sugar, total sugar, and total acid-hydrolyzable substances but are lower in total nitrogen than are green alfalfa leaves from noninfested cages or dusted plots.

Stems of leaf-hopper-yellowed alfalfa plants from nondusted plots are lower in dry matter, reducing sugar, total sugar, and total acid-hydrolyzable substances but are higher in total nitrogen than are stems of green plants from dusted plots.

Leaf-hopper-yellowed second-cutting Grimm alfalfa (leaves and stems) from a noncaged area contains only 71 mg. of carotene per kg. of dry matter, whereas green alfalfa from a caged area, in the same small plot, contains 227 mg. per kg.

The constancy of results from these pairs of samples and their agreement with previously published data show that either caging certain alfalfa plants or protecting them by means of sulphur-pyrethrum dust is a satisfactory method of producing samples free from leaf-hopper injury for comparison with samples of alfalfa exposed to natural infestation with leaf hoppers or produced in artificially infested cages.

DIVISION OF FORAGE CROPS AND DISEASES
BUREAU OF PLANT INDUSTRY
U. S. DEPARTMENT OF AGRICULTURE

[9] See footnote 4.

ASTEROID SPOT, A NEW VIROSIS OF THE PEACH[1]

L. C. Cochran and Clayton O. Smith

(Accepted for publication Nov. 20, 1937)

The extreme variation in the leaf expression of symptoms of peach mosaic in peach has given rise to difficulties in the identification of the disease, especially on partially tolerant varieties and under varied environmental conditions. In a study of such widely varying cases, a number of offtype leaf patterns have been found. Some of them are sufficiently different to suggest mutation of the peach-mosaic virus, or the existence of distinct viruses capable of infecting the peach. Transmissible disorders, distinct from peach mosaic, but of the mosaic type, have been reported by Valleau[2] in Kentucky and Cation[3] in Michigan. Atanasoff[4] has described a mosaic on snow-white peach in Bulgaria, similar in some respects to the asteroid spot, but different from peach mosaic as described by Hutchins *et al.*[5] The purpose of this paper is to report and describe a transmissible disease affecting peach, which the authors believe is distinct.

HISTORY

The disease was first observed in 1934 on leaves of a root shoot of a hybrid peach tree, which had been developed in earlier peach breeding work at the Citrus Experiment Station. The seedling understock of this tree was grown and budded by a local nursery and the budded tree was planted in the station plot in 1919. In the process of the breeding experiment most of the trees were discarded, but some were saved and used as stocks for a prunus species nursery. One of these was grafted with scions of *Prunus alleghaniensis* in 1924. No abnormalities were noted in the grafted tree until 1934, except in one season when the leaves of the *P. alleghaniensis* developed numerous small dark purple spots, which were not associated with the present disorder. Upon the discovery of the condition, buds from the mottled shoots were placed in a seedling from an open pollinated S. P. I. *Amygdalus* Sp. No. 40001. The leaves on the peach shoots from the inserted buds developed typical spotting. The S. P. I. understock showed no spotting until 1937, when faint but easily recognizable spots developed on leaves near the graft union. This was indicative of the transmissible nature of the disease and attempts of further transmission were begun.

[1] Paper No. 384, University of California Citrus Experiment Station and Graduate School of Tropical Agriculture, Riverside, California.

[2] Valleau, W. D. A virus disease of plum and peach. Kentucky Agr. Expt. Sta. Bull. 327: 89–103. 1932.

[3] An unpublished paper entitled, "A rosetted-mosaic of peach and plum trees," by Donald Cation, was presented at the 1935–1936 A.A.A.S. meetings in St. Louis. The senior author was shown peach trees affected by the rosetted-mosaic virus by Mr. Cation in 1935 and the symptoms appeared different from the asteroid spot described in this paper.

[4] Atanasoff, D. Mosaic disease of drupaceous fruit trees. God. Sofiisk. Univ., Agron.-Lesov. Fakult. (Ann. Univ. Sofia, Facult. Agron. et Sylvic.) (V, 1934–35. 1, Agron.) **13**: 9–42. 1935.

[5] Hutchins, L. M., E. W. Bodine, and H. H. Thornberry. Peach mosaic, its identification and control. U. S. Dept. Agr. Circ. 427. 1937.

SYMPTOMS AND NAME

The name asteroid spot has been assigned to the new malady because of the similarity of the leaf-spots to small star-shaped splotches. These spots appear as if small droplets of a thick yellow liquid had been thrown uni-

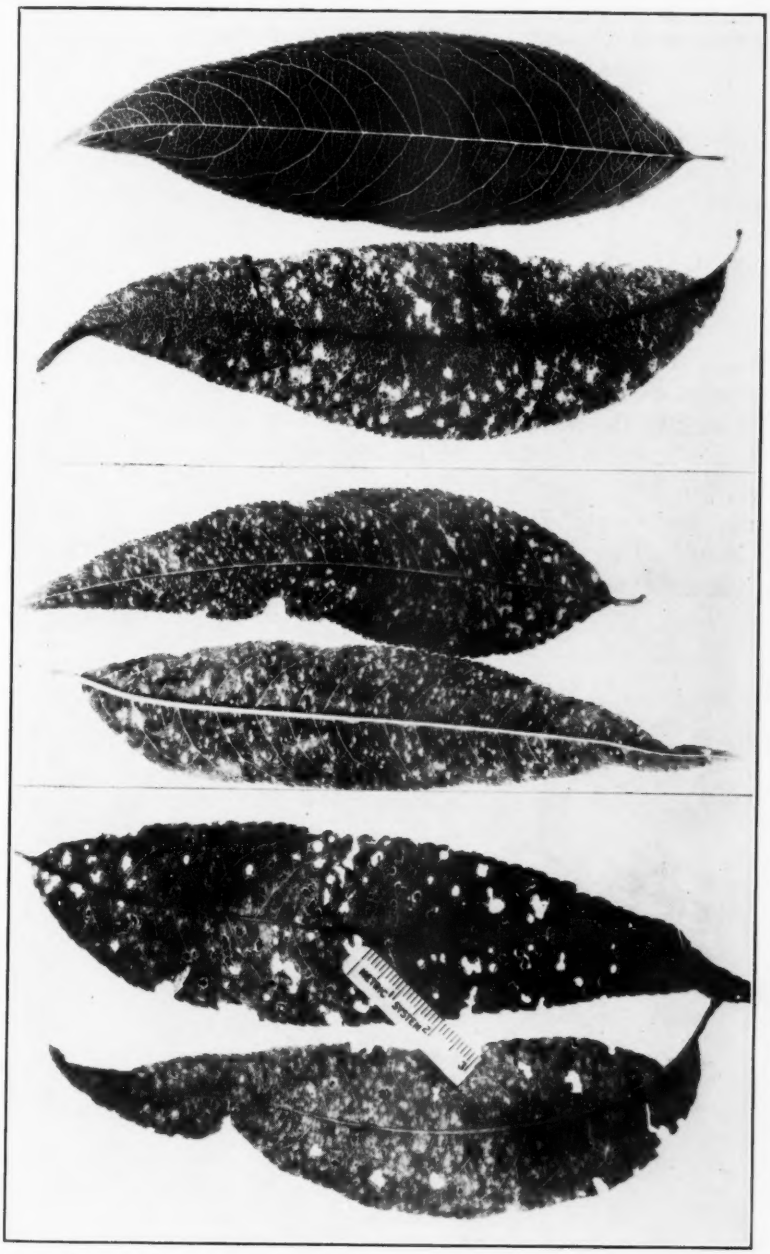

FIG. 1. Peach leaves showing typical leaf symptoms of asteroid spot. The four leaves at the bottom are from a naturally affected seedling peach. The two leaves at the top are from diseased and healthy J. H. Hale peach nursery trees. The diseased Hale leaf came from an artificially inoculated tree.

formly over the surface of the leaves and each droplet on incidence of hit had splattered in all directions (Fig. 1). The spots occur singly and vary in size with the number on the leaf. Newly formed leaves on the affected plants appear entirely normal, and the spots do not become evident until the leaves are fully expanded. On the darker green leaves the spots appear yellow on a green background, but as the leaves become older they turn prematurely yellow and reverse the color combination. The original fully formed spots are, in reality, light green, and do not change further, even though the leaf becomes entirely yellow. In the latter condition the spots appear light green on a yellow leaf. With the first development of yellow in the tissue surrounding the spots, affected leaves form abscission layers and are shed.

Three J. H. Hale peach-nursery trees, growing in 5-gallon cans in the greenhouse were grafted in February, 1937, with scions from peach affected with asteroid spot. After 8 weeks, fully expanded leaves on the Hale branches below the grafts had developed discernible spots. The disease progressed rapidly in one of the trees; and the tree shed its leaves and died. After 5 months the disease had invaded several branches below the grafts in the other inoculated trees, and older leaves had abscissed. Typical spots developed in leaves on shoots growing from the peach seedling understock of one of the inculated Hale trees, but were less intense than those on Hale peach leaves. The scions on all the trees grew for a short time, but later shed their leaves and died.

FIG. 2. Typical early summer leaf patterns of peach mosaic on J. H. Hale peach leaves.

Since the disease has not been seen on other than young shoots and nursery trees, the complete effects on peach are not known.[6] However, the trouble is recognized as a possible serious disease of peach, entirely unlike peach mosaic (Fig. 2), and should be handled only under controlled conditions. The writers plan to test the virus on other hosts, and then it will be destroyed.

CITRUS EXPERIMENT STATION,
UNIVERSITY OF CALIFORNIA,
RIVERSIDE, CALIFORNIA.

A BACTERIAL BUD AND STEM ROT OF ROCKET LARKSPUR[1]

P. A. ARK, C. M. TOMPKINS, AND R. E. SMITH

(Accepted for publication January 12, 1938)

A bacterial disease of rocket larkspur, *Delphinium ajacis* L., was observed in commercial seed fields in the spring of 1933 at Salinas, California. The disease occurred in localized areas but in subsequent years was more general in distribution, frequently killing a high percentage of the plants. Heavy infections always caused a marked reduction in yield of seed because of fewer plants at harvest time.

In 1935, Dodge[2] described a bacterial disease of *Delphinium ajacis* that caused a blackening and rotting of the aerial parts and stunting of the plants. Later, Chester[3] published an account of the causal organism, which he identified as *Erwinia phytophthora* (Appel) Comm. S.A.B.

SYMPTOMS OF THE DISEASE

In California, the disease was observed only on larkspur plants in the flowering stage. Characteristic symptoms consisted of a large number of yellow leaves, blackening of the stem, and stunting of the plants. The disease may start from the terminal buds or from the base of the lower leaves and spread downward through the stem. Invaded tissues are water-soaked and translucent at first, but later turn black. The bacteria are found principally in the cortical tissues, but, in later stages, they penetrate the vascular system. Diseased plants are not always killed but may survive infection and produce flowers and seed. Under moist conditions, however, the progress of the disease is rapid and invariably soft rot of tender plant parts ensues.

There is some evidence that the disease is carried in or on the seed. For

[6] Since this paper went to press, peach mosaic inspectors called the attention of the writers to a leaf spot on peach found in a commercial orchard. The planting was composed of several varieties, but the trouble was found only on the Red Bird variety. Although the spots were strikingly similar to those of asteroid spot, no premature defoliation was noted and damage on the affected trees was slight.

[1] Contribution from the Division of Plant Pathology, University of California, Berkeley, California. Nontechnical assistance from employees under the Federal Works Progress Administration is acknowledged.

[2] Dodge, B. O. A bacterial disease of *Delphinium ajacis*. Jour. New York Bot. Gard. 36: 257–260. 1935.

[3] Chester, F. D. A bacterial disease of Delphinium. Phytopath. 27: 855–858. 1937.

example, seeds that were harvested in a field where the disease was prevalent were planted in autoclaved soil and occasionally gave diseased plants. Also, seeds collected from diseased plants in the field were treated in a 1-to-1000 solution of mercuric bichloride and planted in autoclaved soil in the greenhouse. Sometimes, diseased plants were observed.

The problem of insect transmission of the pathogen was investigated. Aphids, *Macrosiphum solanifolii* Ashmead, were caged on artificially infected larkspur plants for 5 days. Transfers were then made by means of a camel-hair brush in lots of 10 infective aphids to each of 25 healthy larkspur seedlings under cloth cages. After the aphids had fed on these plants for 2 days, the cages were removed and the plants fumigated. After four days, 5 plants became infected, showing typical symptoms of the disease. The organism was recovered in pure culture from each of these plants and proved to be identical with the stock culture. These limited tests indicate that, under certain favorable conditions, aphids may possibly be a factor in the natural spread of the disease.

THE CAUSAL ORGANISM

The causal organism described by Chester[4] was identified by him as *Erwinia phytophthora*. The taxonomic position of the organism responsible for the bacterial bud and stem rot of larkspur in California corresponds rather closely with *E. phytophthora*. However, it should be noted that there were some cultural differences between various isolates. Thus, some isolates did not reduce nitrates or utilize lactose. Some utilized glycerine in synthetic media with the production of acid and gas, while other isolates produced only gas. Hydrogen sulphide tests were positive for all isolates. These differences in the soft-rot group of organisms, observed by many investigators, were fully discussed by Leach.[5]

HOST RANGE

Young cultures of numerous varieties of *Delphinium*[6] were tested for susceptibility to infection by spraying them with a bacterial suspension or by puncturing the stems of large plants with a needle charged with bacteria. The following species and varieties of *Delphinium* were successfully infected: *Delphinium ajacis* L., *D. consolida* L., *D. elatum* L., *D. elatum* L. var. *duhinbergi*, *D. exaltatum* Ait., *D. geyeri*, *D. orientale* T. day Borisove, *D. perigrinum* L., *D. requienii*, *D. taitsiense*, *D. triste*, *D. hybridum* Prinz Gustav. *D. triste* was only slightly susceptible. The following varieties were grown from the seed and found to be susceptible: Giant Imperial Blue Bell, Blue Spire, Miss California, Daintiness, Carmine King, Lilac Spire, Los Angeles, New Lilac, White Spire, Stock-flowered Ageratum, Blue, Dark Blue, La France, Lustrous Carmine, Rosamund, Rose Queen, and White.

[4] See footnote 3.

[5] Leach, J. G. Blackleg disease of potatoes in Minnesota. Minnesota Agr. Expt. Sta. Tech. Bull. 76. 1931.

[6] The writers are indebted to Mr. C. O. Blodgett, Division of Genetics, who kindly supplied seeds of many varieties of *Delphinium* for these tests.

Carrot, *Daucus carota* L., roots and potato, *Solanum tuberosum* L., tubers inoculated with the larkspur organism rotted very promptly.

CONTROL MEASURES

According to Dodge,[7] thorough drenching of plants and the adjacent soil with Bordeaux mixture will prevent or check the disease. Studies of control measures in California have been confined to seed treatment. Various concentrations of mercuric bichloride proved ineffective.[8] In field trials in 1937, clean, healthy plants developed from seed that had been treated in hot water at temperatures ranging from 50° to 55° C. for ten minutes. Control plants from nontreated seed showed 18 per cent infection. The results suggest that the organism may be carried in the seed. For practical purposes, it is believed the hot water treatment of seed will give satisfactory control of the disease.

SUMMARY

A bacterial bud and stem rot of rocket larkspur, prevalent in California, has been described.

Except for minor differences, the causal organism agrees rather closely with *Erwinia phytophthora*.

All tested varieties of *Delphinium* were susceptible to infection under greenhouse conditions.

The disease may be controlled by treating the seed for 10 minutes in hot water at 50° to 55° C.

UNIVERSITY OF CALIFORNIA,
BERKELEY, CALIF.

ALGAL FRUIT SPOT OF ORANGE

J. R. WINSTON[1]

(Accepted for publication January 28, 1938)

The alga, *Cephaleuros (virescens) mycoidea* Karst., attacks a wide range of plants in tropical and subtropical regions. It has been reported at various times on numerous hosts in Florida, including citrus species, of which limbs, twigs, and leaves have been attacked. The disease of citrus caused by this alga rarely, if ever, occurs on the dry sand hills of the interior, but is fairly common on the lowlands along the Florida coast. It is more abundant in the southern part of the State, but even there this alga has not heretofore assumed economic importance. Ruehle, in Plant Disease Reporter, vol. 20, no. 14, August, 1936, reported the disease as being unusually abundant in 1936, and listed the hosts that were found infected. No account of the occurrence of the alga on the fruit of citrus has been located in the literature.

[7] See footnote 2.

[8] The writers found that 1-to-1000 or even 1-to-2000 solutions of $HgCl_2$ (five- and ten-minute treatments) were injurious to larkspur seeds, causing delayed germination and producing very unthrifty plants.

[1] Senior horticulturist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture.

In May, 1937, the writer first saw this hitherto unobserved blemish on the rind of Lue Gim Gong oranges (*Citrus sinensis* Osbeck) then being processed for marketing (Fig. 1). The blemish was a distinctly dark brown to almost black spot, much darker than melanose or exanthema lesions, slightly raised, and with irregular to acutely pointed margins suggestive of lateral root-like developments (Fig. 2). Few, if any, of the blemishes were

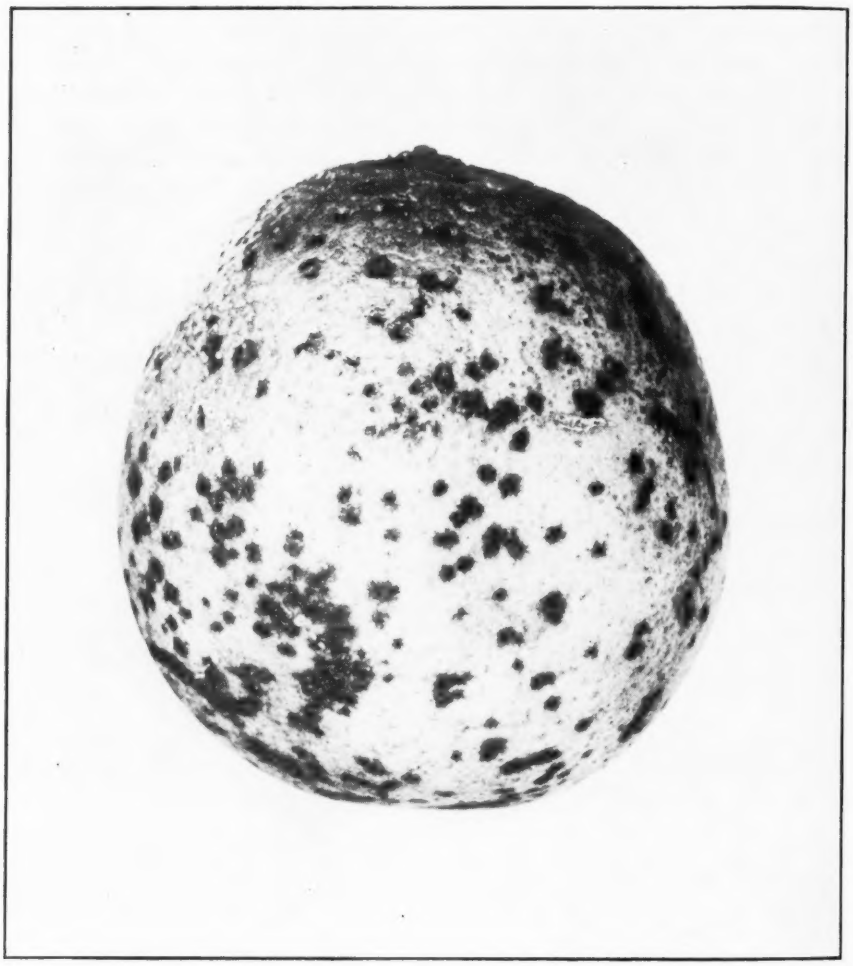

FIG. 1. Lue Gim Gong orange showing spots caused by *Cephaleuros (virescens) mycoidea* Karst.

as much as 2 mm. in diameter, and most of them were about 1 mm. or slightly less. Free-hand sections through the affected parts showed a slight penetration and a discoloration, rarely extending deeper than 3 or 4 cells into the flavedo. Identification of the causal organism was made by H. R. Fulton and J. A. Stevenson of the Bureau of Plant Industry and typical specimens were deposited in the Bureau herbarium.

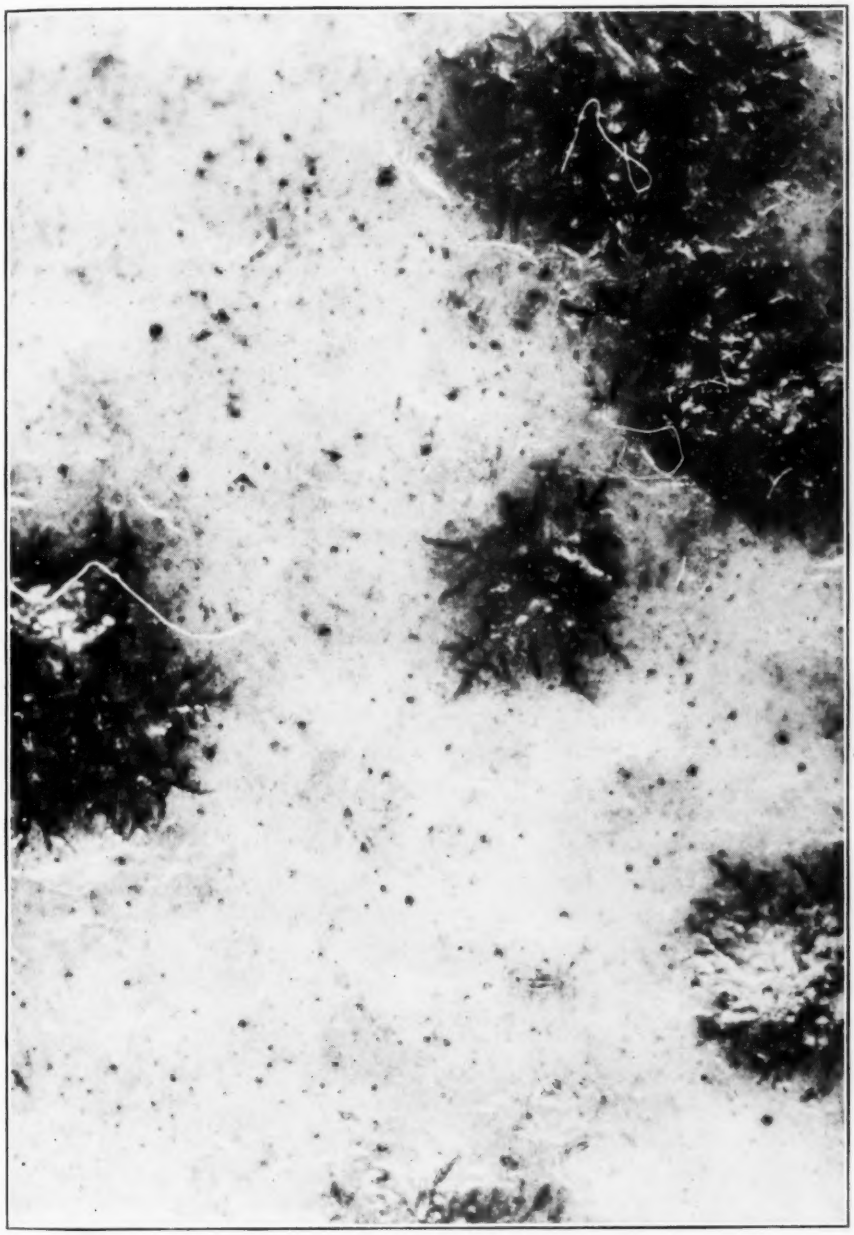

FIG. 2. Enlarged view of alga spots showing root-like appearance.

The infected fruit was produced on 7- to 9-year-old trees in a 400-acre grove located on the edge of the Everglades, about 8 miles southwest of Fort Lauderdale. This grove was inspected on June 9, while both mature and very immature fruits were on the trees, and at several other times during the summer and fall. Although the disease was found to be rather wide-

spread, it affected but a small percentage of the crop. Liberal samples of fruit from the grove have been held under observation at 80° F., but no evidence has been obtained thus far to suggest that the algal lesions contribute to decay development. Since the Lue Gim Gong oranges harvested in 1937 developed from bloom that opened in the spring of 1936, it is likely that the infection herein reported was a part of the general outbreak reported by Ruehle. Limb and twig infections are not difficult to find, but no infected fruit from 1937 bloom has been found.

The conditions in the grove where the infected fruit was found are worthy of note. The grove is located on drained saw-grass muck land where the muck varies in depth from 5 feet to but a few inches and has a pH ranging from 4.3 to 8.3. The trees are set on ridges with small drainage ditches every 90 feet, emptying eventually into a large drainage canal. Weeds and vines, particularly the cucumber vine, overrun the trees unless mowed frequently and cause the loss of much of the tree foliage, thereby weakening the twigs. It is probable that these conditions favor the development of *Cephaleuros* and render the trees more susceptible to other diseases, as well.

PHYTOPATHOLOGICAL NOTE

Mosaic Resistance in Nicotiana tabacum L.—A breeding program having for its object the production of mosaic-resistant tobacco varieties of types suitable for culture in this country has been in progress for several years. In connection with this project, studies have been made to determine (a) the occurrence of resistance to common tobacco mosaic, and (b) genetic factors affecting resistance.

Tests of 897 seed collections from Mexico and Central and South America, the natural habitat of the species *Nicotiana tabacum,* have yielded 36 lots resistant to mosaic. All came from Colombia, South America. In addition to the variety Ambalema, previously reported by Nolla and Roque,[1] 6 additional distinct named varieties resistant to mosaic were obtained. Despite the fact that mosaic is a common disease throughout the region from which these resistant varieties were obtained, there was no evidence that growers there paid any attention to the mosaic-resistant qualities. It would seem likely that these varieties may be an inheritance from the early and highly developed Indian agriculture that was centered in this area.

Tests with the different mosaic-resistant collections have shown that none are immune. Under suitable conditions they become systemically infected and produce from very slight to rather marked leaf symptoms (Fig. 1). On the basis of leaf symptoms, 3 classes of resistance have been established:

Class 1. None to very faint markings.
" 2. Distinct diffuse spotting.
" 3. Mild systemic mottling.

Studies on the inheritance of resistance showed that resistant lines, de-

[1] Nolla, J. A. B., and Arturo Roque. A variety of tobacco resistant to ordinary tobacco mosaic. Jour. Dept. Agr. P. R. 17: 301–303. 1933.

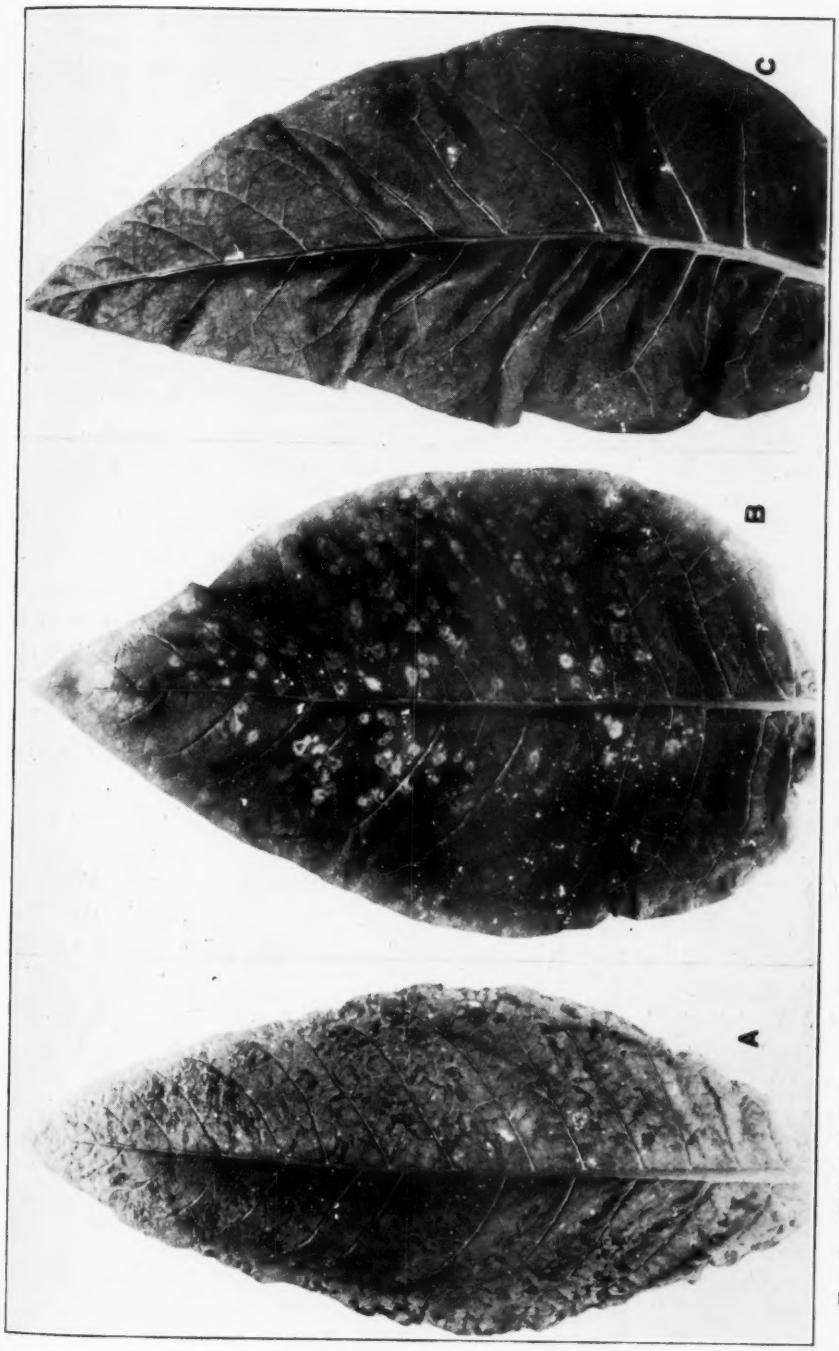

FIG. 1. Effect of degree of resistance on tobacco mosaic symptoms. A. Leaf from a susceptible plant showing characteristic mottling. B. Leaf from a resistant plant having the two Ambalema genes for resistance plus modifiers; the result is the Class 2, diffuse spotting reaction. C. Leaf from a plant having the same resistance genes without the modifiers; result, a Class 1 reaction.

rived from crosses between Ambalema and susceptible domestic varieties, gave, for the most part, a Class 2 reaction. Some of these lines segregated in the F_3 generation, yielding individuals with the Class 3 reaction; which, in turn, produced uniform F_4 populations of this mild-systemic or least-resistant type.

In 1936, tests with both the original F_2 (Ambalema × susceptible variety) and F_2's from resistant selections crossed again with susceptible varieties gave a close approximation to a 15 susceptible to 1 resistant ratio. The total population studied was 8,827 and the value for deviation divided by probable error was 0.76. It was concluded that 2 independent pairs of recessive genes are of major importance in controlling resistance. This verifies a conclusion tentatively reached by Valleau.[2]

As further proof of this conclusion, in 1937 4 first-generation populations, obtained by backcrossing the original F_1's to Ambalema, segregated into a ratio that closely approximated the expected 3 susceptible to 1 resistant. The number of individuals was 2,038 and the value for deviation divided by probable error was 0.50.

However, in 1937, 23 F_2 populations derived from the second backcross of resistant selections to susceptible parent varieties, gave only about two-thirds of the expected number of resistant plants. This deficiency was statistically significant and not a chance variation, since the deviation from a 15:1 ratio was 23.79 times the probable error, and a large population of 27,202 individuals was tested. It is believed that the reduced number of resistant plants was due to the occurrence of many individuals with the Class-3 type of resistance, which, on the basis of symptoms produced on young plants, cannot be separated readily from susceptibles.

We have, then, 3 indications of the existence of genetic factors that modify the expression of the 2 basic-resistance genes; they are:

(1) The decreasing proportion of typical resistant plants in the F_2 after the second backcross to the susceptible parent. This can be explained on the basis of accumulating modifying genes that reduce the resistance from Class 1 or 2 to Class 3.

(2) Resistant F_2 selections, from Ambalema crossed with susceptible varieties, breed true for resistance in the F_3, but may segregate for Classes 1, 2 and 3.

(3) Different degrees of resistance were found in the collections obtained from Colombia. F_1 crosses between Ambalema and different collections falling in Classes 1 and 2 were all resistant, showing that the 2 major recessive genes for resistance were the same in each. Differences are caused by modifiers.

The existence of these modifying genes which reduce mosaic resistance offers a very definite problem in a breeding program that involves frequent backcrosses to the susceptible parent.—E. E. CLAYTON, H. H. SMITH, and H. H. FOSTER, Division of Tobacco and Plant Nutrition, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

[2] Kentucky Agr. Exp. Station, Ann. Rpt. (1936) **49**: 28–29. 1937.

BOOK REVIEW

HEALD, FREDERICK DEFOREST. *Introduction to Plant Pathology.* 1st Ed. 579 pp. McGraw-Hill Book Company, New York and London. 1937. $4.00.

An event of great importance to teachers of plant pathology is the publication of a new book, *Introduction to Plant Pathology,* by Dr. F. D. Heald, which should prove as satisfactory a teaching text as his *Manual of Plant Diseases* is as a reference work. The pages of the new book are replete with valuable information expressed in such a clear, forceful style that it might well be a model for biological text books of the future.

The *Introduction to Plant Pathology* retains much of the material found in his larger *Manual of Plant Diseases,* but it is rearranged and presented in such an order that the student, after being introduced to the study of plant diseases in a general way, is led directly into the section dealing with maladies caused by the higher fungi. Teachers in general will recognize the pedagogical value in the student's having an early introduction to those diseases of greatest interest and importance. A valuable, though rather abbreviated, section on phytopathological methods very properly comes at the end of the text, as few students would be concerned with the technique of investigational work before they had studied specific diseases.

The entire text is evidently the result of careful planning. The diseases discussed are without exception those that would be of interest and importance throughout the United States and Canada. The author employs the sound pedagogical system of describing fully the characteristics of a few typical diseases caused by members of the various important groups of the fungi, bacteria, and other pathogenic agencies. The representative of each group was aptly selected because of its widespread importance, its historical interest, or its value in illustrating some particularly important feature.

While Heald uses the mycological rather than the host basis for arranging his material, he changes the arrangement usually employed by placing the bacterial diseases after those caused by the true fungi. The characteristics of the different groups of the fungi are presented in considerable detail at the beginning of the various chapters. Had some type of descriptive key to the various groups of colorless thallophytes been included in one of the introductory chapters for general reference, the student might get an even broader perspective and a better grasp of this phase of the subject matter than he can with its present treatment.

There are a few cases of inconsistency, especially in terminology, that might have been avoided. It is unfortunate, for instance, that the author, while treating of physiologic specialization, did not use the term "physiologic races" exclusively, although it may be that he distinguishes in his own thought between "physiologic races," "physiologic strains," and "biologic strains." Likewise, if he had used only the Bergey (*et al.*) system of classifying bacteria, he would have been saved the embarrassment of having at times to employ the nomenclature of that system, while he, himself, sponsors that of Migula.

The viroses and problems associated with them are treated comprehensively. It would be difficult to improve upon the organization of this important section of the text, the entire subject of plant viroses being covered in a condensed treatment to better advantage than in any general text known to the reviewer.

The nonparasitic diseases are discussed thoroughly, possibly at the expense of some of the parasitic troubles of greater importance. It is noticeable, at least, that the author does not need to cite a list of supplementary physiologic diseases not discussed in the text.

The chapter on the relation of fungi and bacteria to human affairs contains a great deal of useful information. It is material, however, that probably could be more suitably presented in text books of general botany or microbiology than in one of plant pathology. If the pages thus employed had been used in presenting a good glossary, the text might be even more useful to the beginning or advanced student in plant pathology than it is now.

Like other text books and, indeed, like scientific papers in general in the field of plant pathology, the "Introduction" does not give a complete picture of the signs and symptoms of the various diseases from a developmental basis. The characteristics that mark the final stage of the diseased condition are usually adequate, but there seldom is a description of the early stages with an account of the changes in color, elevation, and other features that occur as the disease develops. The incorporation of descriptions of such a type probably would be one of the greatest contributions that Dr. Heald could make to a later edition, when he thinks that the present one needs revising.

Those errors that occur, including those of omission, however, are relatively few and can easily be explained by the fact that the author probably endeavored to keep the text in reach of the undergraduate student, both in a financial and pedagogical sense.

It should be emphasized that plant pathologists, especially those engaged in teaching, are deeply indebted to Dr. Heald for a modern, general textbook on plant diseases, which, in the reviewer's opinion, is the best that has ever been published for the general college student, county agent, and extension specialist. Its appearance should be regarded as one of the prominent landmarks in the history of plant pathology.—H. H. HAYMAKER, Kansas State College, Manhattan, Kansas.

REPORT OF THE TWENTY-NINTH ANNUAL MEETING OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

THE 1937 INDIANAPOLIS MEETING

A very successful and well-attended meeting was held at Indianapolis, Indiana, December 27 to 30, 1937. H. W. Anderson, University of Illinois, was elected president for 1938; R. W. Goss, University of Nebraska, vice-president; and J. J. Christensen, University of Minnesota, councilor. R. S. Kirby, Pennsylvania State College, was appointed secretary *vice* G. H. Coons, resigned; H. A. Edson, U. S. Department of Agriculture, was reappointed treasurer and business manager of PHYTOPATHOLOGY; and H. B. Humphrey, U. S. Department of Agriculture, was reappointed editor in chief of PHYTOPATHOLOGY.

About 200 members were present, and the annual dinner was enjoyed by approximately 300. The election of 124 new members brought the active enrollment, for the first time, above the thousand mark, to 1,053. The scientific program included 126 prepared papers. Special conferences were held on problems relating to plant quarantines and seed-borne diseases and on extension methods in plant-disease control and their results. Group attack on important plant-disease problems was advanced in special meetings held by members of the Tobacco Disease Council and Cotton Disease Council. Arrangements were made for a symposium program in connection with the Ottawa meeting in June 1938.

The necessity for closest cooperation between different groups of scientists in solving important problems of agriculture was recognized in a joint symposium at which entomologists and plant pathologists discussed the manifold relationships of insects in the spread of many diseases of fruits, truck crops, grain crops, trees, etc. Joint sessions were held with Section G, A. A. A. S., the Mycological Society of America, the Potato Association of America, and the Floriculture Section of the American Society for Horticultural Science.

OFFICERS, REPRESENTATIVES, AND COMMITTEES FOR 1938

Officers:

H. W. Anderson, President (1 yr.), University of Illinois, Urbana, Ill.
R. W. Goss, Vice-President (1 yr.), University of Nebraska, Lincoln, Nebr.
R. S. Kirby, Secretary (3 yrs. Term expires 1940), Pennsylvania State College, State College, Pa.
H. A. Edson, Treasurer and Business Manager of PHYTOPATHOLOGY (3 yrs. Term expires 1940), U. S. Department of Agriculture, Washington, D. C.
H. B. Humphrey, Editor in Chief of PHYTOPATHOLOGY (3 yrs. Term expires 1940), U. S. Department of Agriculture, Washington, D. C.
R. S. Kirby, Advertising Manager of PHYTOPATHOLOGY (1 yr.), Pennsylvania State College, State College, Pa.

Councilors:

G. W. Keitt (Term expires 1938), University of Wisconsin, Madison, Wis.
Chas. Chupp (Term expires 1938), Cornell University, Ithaca, N. Y.
J. J. Christensen (Term expires 1939), University of Minnesota, St. Paul, Minn.
A. N. Brooks (for the Southern Div.), Florida Experiment Station, Lakeland, Fla.
J. W. Hotson (for the Pacific Div.), University of Washington, Seattle, Wash.

Representatives:

A. A. A. S. Council (1 yr.), W. D. Valleau, S. A. Wingard.
Elector Group V, Division of Biology and Agriculture, National Research Council (3 yrs.), E. C. Stakman (H. P. Barss, alternate). (Terms expire 1940.)
Board of Governors, Crop Protection Institute (3 yrs.), K. J. Kadow (Term expires 1939), C. R. Orton (Term expires 1938), J. G. Horsfall (Term expires 1940).

Tropical Research Foundation (5 yrs.), L. R. Jones (Term expires 1940).
International Union of Biological Sciences, A. G. Newhall.
Board of Editors, American Journal of Botany, G. W. Keitt (3 yrs. Term expires 1940).
Union of American Biological Societies [*and Biological Abstracts*], Editor in Chief (H. B. Humphrey) and Secretary (R. S. Kirby) *ex officiis*, G. W. Keitt, H. A. Edson, D. Reddick, H. P. Barss, Chm.
American Type Culture Collection, C. L. Shear (5 yrs. Term expires 1942).

Standing Committees:

Regulatory Work and Foreign Plant Diseases, C. R. Orton, Chm., H. T. Güssow, J. S. Boyce, W. A. McCubbin, R. D. Rands, J. F. Adams, E. L. Chambers.
Extension Work, Luther Shaw, Chm., Chas. Chupp, R. J. Haskell, A. L. Pierstorff, R. S. Kirby, E. C. Stakman, G. W. Keitt, W. B. Tisdale, I. L. Conners.
Coordination in Seed Treatment Research, C. S. Reddy, Chm., W. E. Brentzel, M. B. Moore, H. A. Rodenhiser.
Phytopathological Classics, H. H. Whetzel, Manager; H. B. Humphrey, Editor.
Necrology, A. G. Johnson, Chm., M. B. Waite.
Investments, H. A. Edson, Chm., N. E. Stevens, Chas. Brooks, F. C. Meier, J. W. Roberts.
Donations and Legacies, F. C. Meier, Chm., E. C. Stakman, N. E. Stevens, J. G. Brown, N. J. Giddings.
New Memberships and Subscriptions, A. J. Riker, Chm., R. M. Lindgren, J. C. Carter, B. A. Rudolph, K. J. Kadow, R. S. Kirby (*ex officio*).

TEMPORARY COMMITTEES

Auditing, J. E. Kotila, Carl Hartley.
Elections, E. E. Honey, H. W. Dye.
Resolutions, E. Carsner, C. E. Owens, C. J. Nusbaum.
Committee on Arrangements, Ottawa Meeting, H. T. Güssow, Chm., F. L. Drayton, H. B. Humphrey.

REPORTS OF OFFICERS, REPRESENTATIVES AND COMMITTEES FOR 1937

Report of the Secretary. The Society year 1937 opened with 965 members and closed with 1053, a net gain of 88. At the Indianapolis meeting 124 new members were elected. Eight former members were restored to the active roll during the year. The Society lost 44 members, 14 by resignation, 5 by death and 25 by suspension for non-payment of dues. Of the full membership, 120 are paid-up life members and 42 are paying $10.00 per year toward life membership.

During his three-year term of service the retiring secretary has enjoyed such a full measure of effective cooperation from the officers, committees, and general membership of the Society that his tasks have been made pleasant. He also has appreciated the efficient services of Mrs. Fred C. Meier in keeping the records and the help of Miss Ruth A. Smith in the correspondence and office work.

HOWARD P. BARSS.

Report of the Treasurer. Statement of accounts for the year ending November 30, 1937.

Receipts:

Balance from 1936		$2,391.54
Annual dues:		
1935	$ 5.00	
1936	29.34	($ 1.00 life)
1937	2,670.56	(270.10 life)
1938	2,017.81	(300.66 life)

1939	13.82 (5.00 life)		
1940	1.75		$4,738.28
Voluntary dues			
1937	$ 10.00		
1938	17.50	27.50	
Publication of abstracts, 1936		129.70	
Items for other accounts included in checks for dues:			
Lyman Fund	$ 5.00		
Publ. papers	31.50		
Subscriptions	1.00		
Sales	7.60	45.10	
To replace check returned by bank		5.00	
Bank error corrected		0.25	
Total receipts			4,945.83
			7,337.37

Expenditures:

Member subscriptions transferred to PHYTOPATHOLOGY			
1935	$ 4.00		
1936	26.64		
1937	3,433.08	3,463.72	
Transferred to Sinking Fund (Building and Loan)		290.66	
Publication of Society material in PHYTOPATHOLOGY (January to June, 1937)		229.33	
Publication of abstracts		114.58	
Proofreading "Classics"		15.60	
Secretarial work for Secretary and Treasurer		287.63	
Printing and mimeographing		154.15	
Stamps and envelopes		88.35	
Supplies		8.35	
Loss on A. P. S. dinner, Atlantic City		1.60	
Contribution to Biologists' Smoker		10.00	
Binding 5 volumes official set of PHYTOPATHOLOGY		8.75	
Embossed parchment		8.23	
Membership committee, expenses		25.70	
Transferred to PHYTOPATHOLOGY for items in checks for dues			
Publ. of papers	$ 31.50		
Subscriptions	1.00		
Sales	7.60	40.10	
Transferred to PHYTOPATHOLOGY for voluntary dues, 1937		10.00	
Telegram		1.81	
Transferred to Lyman Fund		5.00	
Check returned by bank		5.00	
Collection charges on checks		4.75	
Bank error		0.25	
Total expenditures			4,773.56
Balance on hand			2,563.81
			7,337.37

Sinking Fund. The Sinking Fund, the income from which is used for the support of PHYTOPATHOLOGY, is obtained by deducting $5.00 from each $10.00 life-membership installment. This fund totaled $9,036.00 at the close of 1936. During the 11 months January to November, 1937, it has increased to $9,281.66 and is invested as follows:

First mortgage notes deposited with the McLachlen Banking Corporation for collection ($2,000 at 6%, $1,000 at 5½%, $500 at 5%)	$3,500.00
Invested with the following building and loan associations:	
Arlington & Fairfax Bldg. and Loan, 5%	1,000.00
Columbia Permanent Bldg. Ass'n, 4½%	500.00
District Bldg. and Loan Ass'n, 4%	1,000.00
National Permanent Bldg. Ass'n, 5%	525.40
Northwestern Savings and Loan Ass'n, 5%	1,000.00
Perpetual Bldg. Ass'n, 4½%	1,022.50
Prudential Bldg. Ass'n, 4%	781.66
	9,329.56
Less interest payable to PHYTOPATHOLOGY (National Permanent and Perpetual)	47.90
	9,281.66

The Lyman Memorial Fund for the permanent endowment of PHYTOPATHOLOGY, obtained from voluntary contributions, totaled $2,608.81 at the close of 1936. During the 11 months, January to November, 1937, this fund has increased to $2,709.81.

Invested with the Brookland Building Ass'n, 4%	$2,762.76
Less interest payable to PHYTOPATHOLOGY	52.95
	2,709.81

H. A. EDSON.

Report of the Business Manager of Phytopathology. At the end of 1936 there were 592 subscriptions to PHYTOPATHOLOGY including 6 complimentary. During 1937 there were 33 cancellations, and 27 suspensions for non-payment (including our total subscription list for Spain), a loss of 60, but with 82 new paid and one new complimentary subscription, the net gain is 23, increasing the list at the close of 1937 to 615. Of these 185 are domestic and 430 are foreign. Japan leads with 67, U. S. S. R. has 54, England 37, Canada, 26, Argentina and China 23 each and Germany 22. Sixty-two other countries or geographical units receive from one to 19 copies each.

Statement of accounts for the year ending November 30, 1937.

Receipts:

Balance from 1936		$ 1,407.49
Subscriptions:		
1936	$ 65.60	
1937	3,173.35	
1938	343.69	
1939	11.35	
1940–1943 (5.85 each)	23.40	$3,617.39
Member subscriptions, 1935, 1936		30.64
Voluntary dues, 1937		10.00
Member subscriptions, 1937		3,433.08
Sales of back numbers		423.80
Advertising:		
1936	$ 229.87	
1937	958.48	1,188.35

Interest on Sinking Fund:			
First mortgage notes	263.06		
Building and loan	143.31[1]	406.37	
Interest on Lyman Fund		51.60[2]	
Publication of papers, 1936		150.50	
From A. P. S. for publication of Society material		229.33	
Allowance on reprints by printer		51.93	
First mortgage note paid in full		1,000.00	
Total receipts			10,592.99
			12,000.48

Expenditures:

Printing and distributing PHYTOPATHOLOGY:			
Vol. XXVI, No. 12 (containing Index)	$ 627.52		
Vol. XXVII, No. 1	$692.05		
No. 2	566.99		
No. 3	667.54		
No. 4	372.97		
No. 5	395.61		
No. 6	462.07		
No. 7	412.25		
No. 8	472.66		
No. 9	477.67		
No. 10	472.33		
No. 11	629.78	5,621.92	
Postage	533.99	$6,783.43	
Secretarial work for Editor in Chief		353.86	
Secretarial work for Business Manager		155.06	
Secretarial work and expenses of Advertising Manager		32.85	
Commission, Advertising Manager		98.96	
Stamps and envelopes, Bus. Mgr. and Editor in Chief		84.18	
Supplies		3.30	
Printing		36.00	
Reinvestment, Sinking Fund		1,000.00	
Refund subscription		5.85	
Refund, sales		2.25	
Charge for collection of check		0.15	
Total expenditures			$ 8,555.89
Balance on hand			3,444.59
			12,000.48

H. A. EDSON.

Report of the Auditing Committee for the Year Ending November 30, 1937. The books of the Treasurer of the Society and the Business Manager of PHYTOPATHOLOGY have been examined, together with the present investments of the Sinking Fund and the Lyman Memorial Fund. The accounts have been found correct and the books in very excellent order.

December 20, 1937. J. E. KOTILA, CARL HARTLEY.

[1] $47.90 of matured interest has been left invested until needed.
[2] $52.95 of matured interest has been left invested until needed.

Report of the Advertising Manager. The 1937 advertising receipts of $1,182.05 from PHYTOPATHOLOGY are the largest for any of the past six years. The 1937 receipts were $201.50 greater than those of 1936, or a percentage increase of 20.4.

The total number of advertisements run in 1937 was 204. Of these, 153, or 75 per cent, were revenue advertisements, 32 were full-page, 49 were half-page, 56 were quarter-page, and 16 were one-eighth page advertisements.

The increase of $201.50 in the amount of receipts from advertising was due to better business conditions and to aid of members in helping the advertising manager contact new sources for advertising.

Fifty-one advertisements occupying 37.5 pages were non-revenue-producing. These consisted of exchange advertisements with other journals, space occupied by the Directory of Advertisers, announcements of meetings, and Phytopathological Classics.

During 1937, 22 concerns purchased advertising space in PHYTOPATHOLOGY.

R. S. KIRBY.

Report of the Editor in Chief. PHYTOPATHOLOGY, Volume 27, 1937, comprises, exclusive of the index, 1,185 pages (25 pages more than in Volume 26) of printed matter, including illustrations, classified as follows: Eighty-eight articles, 34 phytopathological notes, 2 reports of regional and other meetings, 5 book reviews, 93 abstracts (4 by title only), 177 text figures, 3 plates, and 2 frontispieces. From Jan. 1 to Dec. 31, 1937, 108 manuscripts of articles, notes, reports, and book reviews were submitted for publication in PHYTOPATHOLOGY. Of this number 2 were not accepted, 1 was recalled by the author, and 33 were returned to their authors for more or less complete revision and condensation. Of those manuscripts received in 1936, but too late for publication in Volume 26, 12 were returned to their authors for revision. The index for Volume 27 was published in the December number.

Manuscripts submitted during the current year have shown an appreciable improvement in organization of subject matter, conciseness, clarity, and picturization, and also in their value as contributions to our accumulating knowledge of plant pathology. The journal and, incidentally, the Society have profited measurably through the editorial assistance of Dr. F. V. Rand, who kindly prepared the index for Volume 27. The Society also is indebted to The Science Press Printing Company for its share in enabling us to publish a journal of distinction from the standpoint of printers' craftsmanship.

H. B. HUMPHREY.

Report of the Manager of Phytopathological Classics for the fiscal year December 15, 1936, to December 15, 1937.

Classics No. 1:	On hand 12–15–36	220	
	Sold during year	45	
	On hand 12–15–37		175
Classics No. 2:	On hand 12–15–36	419	
	Sold during year	41	
	On hand 12–15–37		378
Classics No. 3:	On hand 12–15–36	545	
	Sold during year	57	
	On hand 12–15–37		488
Classics No. 4:	On hand 12–15–36	609	
	Sold during year	52	
	On hand 12–15–37		557

Classics No. 5: Printed August, 1937		1091
	C. R. ORTON,	
Sold	180	
Gratis	12	
Disposed of during year	192	
On hand 12–15–37		899

Cash balance on hand Dec. 15, 1936	$418.09	
Receipts during year	277.18	
Total cash income		$695.27
Expenditures:		
Printing Classics No. 5	$601.76	
Advertising	6.48	
Postage, etc.	45.26	
Stationery and supplies	17.66	
Total cash expenditures		$671.16
Balance on hand 12–15–37		$ 24.11
Balances due on account 12–15–37		$ 41.50

H. H. WHETZEL.

Report of the Committee on Necrology. During the calendar year 1937, there have been five deaths of members as follows:

Dr. J. J. Davis, February 26.
Mr. Stacy O. Hawkins, July 10.
Dr. G. P. Clinton, August 13.
Dr. F. Sattler, September 12.
Dr. J. J. Taubenhaus, December 13.

A. G. JOHNSON,
M. B. WAITE.

Following the reading of the necrology report the members present stood for a moment in silence in honor of their departed colleagues.

Report of the Representative for Group V in the Division of Biology and Agriculture of the National Research Council. The three-year term of your representative ended July 1, 1937. The representative for Group V (bacteriology, plant pathology, mycology) for the present three-year term is Dr. E. C. Fred, Agricultural Bacteriologist, University of Wisconsin. Of interest to this Society among the activities of the Division during the past fiscal year was the establishment of two important interdivisional committees, which include other groups of sciences embraced within the National Research Council with the Division of Biology and Agriculture. The first is a Committee on the Genetics of Pathogenic Organisms, E. C. Stakman, Chairman. This committee is organizing a symposium on this subject in relation to human welfare for the Ottawa meeting in June 1938. The other is the Committee on Aerobiology, Fred C. Meier chairman. This committee is concerned with the aerial dissemination of microorganisms and such other disease-producing agents as viruses and allergens affecting the health of animal and plant life as well as that of humanity. The object of these committees is to facilitate the bringing together of representatives of various scientific groups in these fields for mutual assistance in order to promote the most rapid advancement of important knowledge through better-coordinated efforts. E. C. Stakman was appointed vice-chairman of the Division of Biology and Agriculture for 1937–38. Howard P. Barss was appointed representative of the National Research Council on the Board of Governors of the Crop Protection Institute for the three-year period beginning July 1, 1937.

HOWARD P. BARSS (R. F. POOLE, Alternate).

Report of the Representatives on the Board of Governors of the Crop Protection Institute. The Institute is organized as a non-profit organization. Its purpose is to make available the services of technically trained men under competent direction for research relating chiefly to the effectiveness of various types of materials or apparatus for the control of plant diseases and insect pests, or similar types of problems, for the benefit of commercial manufacturers needing dependable scientific assistance in these fields and for the ultimate benefit of agriculture, as well as for the advancement of science. The Board of Governors is composed exclusively of representatives elected by The American Phytopathological Society, The American Association of Economic Entomologists, the Association of Official Agricultural Chemists, and the National Research Council. Dr. W. C. O'Kane was again reelected chairman of the Board for 1938.

An active program of research was continued during the year under the auspices of the Institute, with nine major projects in progress on November 15, 1937, in addition to which a considerable amount of preliminary or exploratory work was under way to determine whether certain materials appeared to have sufficient merit to warrant the establishment of formal research projects for their more thorough study.

The Atlantic Refining Co., National Aniline and Chemical Co., Dow Chemical Co., Röhm and Haas Co., Standard Chemical Products, Inc., and General Chemical Co. are contributing to the support of such major projects. Exploratory work was done on the products of some 20 other firms. The work was conducted in various States, including New Hampshire, Connecticut, New York, Delaware, Maryland, Virginia, Indiana, Iowa, Louisiana, and California.

The following bulletins were published in the Institute series in 1937:

No. 61, "Contact Insecticidal Properties of Various Derivatives of Cyclohexylamine," by C. W. Kearns and W. P. Flint.

No. 62, "Evaluation of Cuprous Oxides Recommended as Seed Treatments for the Control of Damping-Off," by H. W. Anderson, K. J. Kadow and S. L. Hopperstead.

No. 63, "Copper Sulfate as a Plant Nutrient and Soil Amendment," by W. L. Churchman, M. M. Manns and T. F. Manns.

W. H. MARTIN,
J. F. ADAMS,
C. R. ORTON.

Report of the Committee on Publication Problems. Following favorable action by the Society at the Atlantic City meeting on proposals submitted by your Committee on Publication Problems, the Editorial Board with the strong backing of the membership of the Society put into operation a more vigorous editorial policy looking toward raising the standards of subject-matter quality and maximum brevity and conciseness consistent with scientific usefulness. Very satisfactory have been the results of the combined efforts of our contributing members and our editors. The number of articles and the quality have increased during the year without demanding increased space. As a result the journal has been able to publish all papers without delay other than that required for editing, necessary revision, and printing.

The Editor in Chief and Business Manager were authorized by the Society at the latest meeting to effect such economies as they deemed wise in the structure of PHYTOPATHOLOGY. Some space-saving measures have been adopted without requiring any essential change in format.

At the close of the year the Journal finds that its income has been adequate. There is every expectation that this will continue and will permit prompt publication of all acceptable contributions during the year ahead. The additional memberships obtained by the Membership Committee, appointed by the Society on recommendation of this Committee, are helping to provide the needed additional support.

In view of the effectiveness of the steps already taken by the Society and the machinery set up by it for still further adjustment, if necessary, in future, the Committee considers its functions completed and requests that it be discharged.

In closing its work, the Committee desires to urge that the members of the Society continue their vigorous support of the Editorial Board and Management of PHYTOPATHOLOGY in maintaining the high standards of quality, conciseness, and economy in publication that they are endeavoring to promote.

H. B. HUMPHREY, H. A. EDSON, R. S. KIRBY, E. C. STAKMAN, N. E. STEVENS, M. W. GARDNER, R. F. POOLE, L. M. MASSEY, L. R. JONES, F. L. DRAYTON, G. W. KEITT, HOWARD P. BARSS, Chairman.

Report of Committee on Regulatory Work and Foreign Plant Diseases. A general meeting of the Society was called in the evening of December 27 to hear reports and discuss phases of the foreign plant-disease and quarantine problem.

A progress report of the subcommittee, prepared by Messrs. Munn, Scott, and Brown, on seed-borne parasites, was presented by the chairman of the meeting. Plans for strengthening the requirements for disease examination of seed stocks passed in international commerce were discussed at the Congress of International Seed Testing Associations in 1937 and are underway in cooperation with committees from other nations. In August, 1937, the subcommittee secured the passage of the following resolution at the meeting in Washington of the Association of Official Seed Analysts. "Resolved, that the Association recommend to all laboratories that in the future they recognize the significance of the plant disease carrying possibilities of seed stocks, and that in providing for the personnel of their staff, and more particularly in arranging report blanks or forms, that provision be made to care for the reporting upon the sanitary condition or health of the seed stock being tested, along with the other factors now being determined." The subcommittee is mindful of proposed federal legislation to regulate the sale and transport of seed stocks in interstate commerce that at present, does not provide for standards regarding the presence of harmful plant diseases.

The following practical suggestions were made by the subcommittee:

1. Steps now being made to appraise the disease-distributing possibilities of the better seed stocks through certification or otherwise should be fully supported by every agency.
2. Seed-testing and control laboratories should be fully supported in their attempts to do the practical determinations possible and then go farther by undertaking definite investigations of the situation as regards the sanitary conditions of the seed stocks being used each season.
3. Every attempt should be made to stop, or at least very materially limit or curb, the movement, sale, or use under the caption of "seed" of great volumes of grains of nondescript origin, variety and sanitary condition now being diverted out of commercial channels and shipped more or less promiscuously over the country, sooner or later to take on the more dignified name of "seed stocks." Our committee believes that the name "seed," in its agricultural sense, should mean something definite. It should mean more than that it will produce a living plant; it should also mean that it will produce a healthy plant.
4. In preparing seed-control legislation and facilities for seed-stock control, there should be given due consideration to the possibilities of restricting, curtailing, or even prohibiting with utmost promptness the movement of definitely disease-infested seed stocks in the same manner as that of weed-seed-contaminated seed stocks, insofar as practicable. Seed-stock control should include whatever is known to be practical in the realm of seed treatments.

The report of the subcommittee was accepted with appreciation and a request that they continue their efforts and report at the next meeting.

At the suggestion of President Keitt, a motion was passed that a subcommittee be appointed to study the subject of State regulatory work and report at the next meeting. Mr. E. L. Chambers was appointed chairman of this subcommittee and Dr. J. F. Adams a member.

A motion was passed that the Council of the Society consider the appointment of a delegate to represent the Society, if called upon to do so, in connection with the work of a committee appointed by the League of Nations to consider matters relating to plant-quarantine regulations.

A motion was passed that the Council of the Society designate a member to attend any conferences called to consider possible Congressional action to govern the entry of pathogens or pests into this country.

Dr. Adams reported the activities of the National Plant Board for 1937, covering (1) nursery inspection and certification, (2) pest emergency, (3) azalea leaf spot, (4) potato wart, (5) standardization of state quarantines, and (6) national weed control.

C. R. ORTON.

Report of the Representative of the Society with the International Union of Biological Sciences. The next meeting of the Union will be held in Stockholm in July, 1940. The Subsection for Phytopathology is in the process of formation now and will be fully organized before the next convention. The officers are: President, Donald Reddick; Secretary, Johanna Westerdijk. The exact procedure to be employed in drafting international legislation is not yet determined, but it is not likely to differ radically from that employed heretofore by the nomenclature committee of the international botanical congresses. Any society, group, or individual doubtless will have the privilege of presenting subjects for consideration and legislation. Presumably, these proposals will have to be distributed in print at least six months before the convention. February, 1940, would thus be the latest date for announcing proposals; but nothing would prevent printing such announcements a year or more in advance.

Three items are pending from the Amsterdam congress.

1. *English, an International Language.* Violent opposition voiced at Amsterdam was based in part on misunderstanding of the proposal. (The proposal was not distributed in advance of the meeting.) It is noticeable, however, that without any legislation at all, summaries in English of papers in other languages are appearing with greater frequency. Our Society is not called upon to support this proposal with any vigor, but we might well pledge cooperation through an endeavor to make our own writings so clear and simple that they can be read with ease rather than with difficulty. Aside from technical words it is likely that a vocabulary of one thousand other words is ample for recording our observations. Most of the papers we publish are documents, not literary productions.

2. *The Nomenclature of Immunology.* A series of definitions was proposed at Amsterdam which was conspicuous because of the lack of a definition for the word immune, itself. Our Society should appoint a committee to study this proposal and make recommendations. Our delegate to Stockholm should be able to present a positive position in this matter.

3. *International Committee for Description and Nomenclature of Plant Viruses.* This committee was formalized at Cambridge and presented a report of progress at Amsterdam. Mimeographed copies of the report were distributed. Although the report is "incomplete" and "preliminary," distribution of copies of it to our members might serve a very useful purpose.

A variety of subjects might well be considered by special committees of the Society with the idea that proposals should be formulated for consideration and international concord.

1. *Word Usage.* Surely, plant pathologists throughout the world should use certain words in a technical sense and with just one definition. This is not being done now and the differences in definition are not confined to the literature of immunology. The proposed committee for study of the nomenclature of immunology might be authorized to broaden the scope of its studies to include the dozen or two dozen words the exact international usage of which would be most helpful in recording our findings.

2. *The Eriksson Institute.* It would be particularly appropriate if a proposal could be made at Stockholm that would make real the international institute of plant pathology

of which Doctor Eriksson used to speak and write on every possible occasion. The Subsection Phytopathology of the Union is, in fact, such an institute. Its professors are the plant pathologists of the world. Its laboratories are the existing laboratories of plant pathology. Its important need is a paid secretary who can give time to the business of coordination of effort, and who will be informed about sources of funds that can be properly applied to the business of the institute.

3. *Naming or Numbering Biotypes, Physiological Races, etc.* A committee of this Society [Humphrey, Stakman, Reddick] has been appointed to study this problem and, if possible, to draft a procedure that the Society may be willing to support at Stockholm.

DONALD REDDICK.

Report of the Resolution Committee. 1. RESOLVED that The American Phytopathological Society express its appreciation to A.A.A.S. committees responsible for the arrangements that have contributed so effectively to the success of the 1937 meeting in Indianapolis.

2. RESOLVED that The American Phytopathological Society convey to the management of the Severin Hotel gratitude for the courteous and efficient service extended to the members attending the 29th annual meeting.

3. Recognizing the splendid condition of our Society and the devoted and time-consuming efforts of our officers and permanent committee members in effecting gratifying advancement:

BE IT RESOLVED, that we express our deep appreciation to them in behalf of the Society.

AND BE IT FURTHER RESOLVED that we pledge ourselves, as members, to cooperate in every possible way with our officers and committees throughout the coming year.

4. RESOLVED that on behalf of The American Phytopathological Society it gives us pleasure to transmit to the Canadian Government and our Canadian colleagues grateful appreciation for the very cordial invitation to the meeting next summer in Ottawa.

5. RESOLVED that the members of The American Phytopathological Society attending the 29th Annual Meeting extend thanks to the entertainment committee composed of Ralph M. Caldwell and Neil E. Stevens for the pleasing program especially the beautiful and artistically rendered songs of Stephen C. Foster, given by the Negro quartette at our annual dinner.

E. CARSNER, C. E. OWENS, C. J. NUSBAUM.

ACTION BY THE SOCIETY AT THE 1937 INDIANAPOLIS MEETING

Elections and Appointments. The appointments made, as provided by the constitution, by the President or the Council since the previous meeting were approved by Society vote in business session. The ballots for the election of officers were unsealed and tallied by the Election Committee. The results were canvassd by the Council and announced to the Society. The names of those elected and appointed appear earlier in this report in the list of "Officers, Representatives, and Committees." Without dissent, 124 new applicants were elected to membership.

Members of the Editorial Board of PHYTOPATHOLOGY elected by the Society on nomination of the Council after consultation with the Editor in chief, H. B. Humphrey, are: Editors (3 yrs. Terms expire 1940), Wm. W. Diehl, C. E. Owens, H. M. Quanjer; Associate Editors (3 yrs. Terms expire 1940), Thorvaldur Johnson, A. J. Riker, W. J. Zaumeyer, Geo. F. Weber.

Following the announcement of the election of G. H. Coons as Secretary, Dr. Coons stated that, although he was appreciative of the honor, the burden of official duties would make it impossible for him to serve the Society in that capacity. This resignation made it incumbent on the 1938 Council to fill the secretaryship, which was done later by the appointment of R. S. Kirby.

Reports of Officers, Representatives, and Committees. The reports for the year 1937, as presented on previous pages, were individually read and accepted by vote of the

Society in business session with the exception of the report of the Committee on Regulatory Work and Foreign Plant Diseases, which was presented more in detail before the conference held under the Committee's auspices Monday evening, December 27.

Amendment to the Constitution on Terms of Office of Division Councilors. After due notice sent to all members early in October, 1937, the members present at the business meeting December 27, 1937, passed without dissent, an amendment to Article V of the Constitution, whereby the last sentence of the second paragraph is changed to read as follows:

> "The term of service of a Council member from a Division shall commence immediately following his election and shall continue until his successor is elected."

Recommendation of Change in Constitution to Provide for Council Appointment of Secretary of the Society. During the year President Keitt appointed a committee (Coons, Chm., Barss, Gardner, Güssow, Reddick, Stakman, with the President *ex officio*) to study sentiment with respect to the present system of electing officers. The Committee reported to the Council that, in general, no change in the present system was favored, except in reference to the secretaryship. After due consideration the Council recommended that the Society be given opportunity to vote at the next annual meeting on an amendment placing upon the Council the duty of appointing the secretary for a term of three years, subject to the usual ratification by the Society.

Subcommittee on State Regulatory Work. On recommendation of the Committee on Foreign Plant Diseases, endorsed by the Council, the Society voted to authorize the formation of a subcommittee on state regulatory work to consider and work out means whereby the Society can be of greater service to those engaged in this important phase of agricultural protection. On Council recommendation the name of the main committee was changed to Committee on Regulatory Work and Foreign Plant Diseases.

Representatives on the Union of American Biological Societies. On Council recommendation the Society voted to discontinue the former Biological Abstracts Committee and to place its functions on the expanded committee representing the Society with the Union of American Biological Societies. At the same time the latter Committee was authorized to approach the membership of the Society in the interest of establishing Biological Abstracts on a permanent, effective basis.

Program Committee. It was voted to lay on the table until the next annual meeting a change in the Standing Rules, Section 4, relative to the constitution and duties of the committee in charge of the programs for annual meetings, which had been recommended by the Council for consideration.

November 10 Set as Latest Date for Receipt of Abstracts of Papers for the Annual Meeting. On Council Recommendation the Society voted without dissent to amend the Standing Rules so as to set November 10 instead of November 15 as the latest date for receipt of abstracts of papers submitted for the annual meetings in order to allow more time for correspondence with authors.

The A.A.A.S. Prize. On Council recommendation the Society voted that the Abstracts Committee shall call to the attention of the Council any papers that might be given consideration in connection with the annual A.A.A.S. Prize.

Place of Next Annual Meeting. On Council recommendation the Society voted to leave to the decision of the Council the place of the next annual meeting.

Representative of the Society in Conferences on Possible Congressional Action Relating to Pathogenic Organisms. On Council recommendation the Society voted to authorize President Keitt and Secretary Barss, after conference with Chairman Orton of the Committee on Regulatory Work and Foreign Plant Diseases, to appoint a delegate to represent the Society at any conferences called in Washington to consider possible Congressional action relative to pathogenic organisms.

Representive of the Society in Connection with the International Plant Quaran-

tine Committee established under the League of Nations. On recommendation of the Council the Society voted to appoint H. A. Edson as its representative to be available in case the Society should be in a position to assist the important international committee established under the League of Nations, as recommended by the International Botanical Congress at Amsterdam and endorsed by this Society, to consider problems related to plant quarantines and similar regulations.

Representative on the Council of the Third International Congress for Microbiology. On recommendation of the Council the Society voted to appoint B. O. Dodge as its representative on the Council of the Third International Congress to be held in New York City in the summer of 1939.

Eriksson Institute. On recommendation of the Council the Society reaffirmed its previous request that D. Reddick with others selected by him formulate for Society consideration proposals relative to the Eriksson Institute.

Membership Lists. On recommendation of the Council the members present voted without dissent that it be the policy of the Society that its membership list be supplied only to members.

Biological Smoker. On Council recommendation the Society voted a contribution of $10.00 from its treasury for the Biologists' Smoker arranged by the American Society of Naturalists at Indianapolis.

Editorial Policy. On recommendation of the Council the Society passed unanimously the following resolution: The American Phytopathological Society endorses the policy of the Editorial Board and pledges its cooperation in the future continuation of the Board's efforts toward attaining the utmost conciseness consistent with high scientific quality in the papers presented in PHYTOPATHOLOGY.

JOHN JEFFERSON DAVIS

November 4, 1852—February 26, 1937

John Jefferson Davis was graduated from the University of Illinois at its first Commencement in 1872 with the degree of Bachelor of Science. In 1875 he received the degree of Doctor of Medicine from the Hahnemann School of Medicine. From 1877 to 1911 he practiced medicine in Racine, Wisconsin. In 1911 he retired from active practice to accept the Curatorship of the University of Wisconsin Herbarium. Although entitled to retirement, he refused to give up active work and he was at his desk as usual on the day of his death.

His medical training aroused in him a desire to study the flora of Wisconsin and in a short time he was exchanging specimens with many of the better-known botanists of that time. He soon realized that it would be necessary to confine his more intensive studies and he decided upon the Rusts and the Imperfect Fungi. At the time of his death he was internationally recognized as an authority on the latter group.

He very early became affiliated with scientific groups, and for more than 50 years he was in attendance at the national meetings. Dr. Davis was a member of several scientific societies and was a charter member and patron of The American Phytopathological Society. He was president of the Wisconsin State Medical Society and, during the last years of his life, was keenly interested in the studies on human cancer.

Dr. Davis did not publish extensively. His lists of the parasitic fungi of Wisconsin are the best known, and the 20th list was completed just one week before his death. He was at all times an inspiration to the younger mycologists; and, if one is to judge by the numerous letters of appreciation found in his files, his influence was more far-reaching than was suspected, even by his most intimate friends and coworkers. His was a most kindly personality, and all who knew him prized his friendship most highly.

STACY OTTO HAWKINS

September 6, 1899—July 10, 1937

Stacy Otto Hawkins was graduated from Indiana University in 1923 with the degree of Bachelor of Arts and received the degree of Master of Arts from the same institution in 1926. During 1921–22 he taught history and botany at Marion College, Marion, Indiana. From 1925 to the time of his death he was employed by the Florida Agricultural Experiment Station in the Department of Plant Pathol-

ogy, first as Field Assistant and later as Assistant Plant Pathologist. From 1925 to 1936 he served at Homestead, Florida, and early in 1936 he was transferred to Gainesville.

Mr. Hawkins made important contributions toward the control of certain vegetable diseases in Florida, particularly certain diseases of tomatoes. It was truly said of him: "He was an earnest and conscientious worker, and was always ready to encourage a worthy cause and help its advancement in any way he could."

GEORGE PERKINS CLINTON

May 7, 1867—August 13, 1937

George Perkins Clinton was graduated from the University of Illinois in 1890 and received the degree of Master of Science from the same institution in 1894. In 1901 he received the degree of Master of Science and, in 1902, the degree of Doctor of Science from Harvard University.

From 1890 to 1900 Dr. Clinton served as Assistant Botanist in the Illinois Agricultural Experiment Station and Assistant in Botany in the University of Illinois. From July 1, 1902, to June 30, 1937, he served as Botanist of the Connecticut Agricultural Experiment Station. From July 1, 1937, to the time of his death, he was retained on the staff of the same institution as Consulting Botanist. From 1902 to 1925 he was also Botanist for the Connecticut State Board of Agriculture. From 1903 to 1927 he was chairman of the committee on fungous diseases of the Connecticut Pomological Society. From 1919 to the time of his death he was one of the three members of the Connecticut Tree Protection Examining Board. From 1915 to 1926 Dr. Clinton was Lecturer in Forest Pathology and, from 1926 to 1929, Research Associate in Botany in Yale University. Dr. Clinton also served temporarily, both in the United States and in foreign countries, on special assignments for the U. S. Department of Agriculture and for Harvard University.

In addition to being a sustaining life member of The American Phytopathological Society, Dr. Clinton was an honored member in numerous other scientific and agricultural societies. It was well said of him that he was "sincere, honest, generous, loyal, democratic, determined, and just." He also had a keen sense of humor and an intense hatred of pretense. He was deeply religious and for those in sorrow, he was tenderly sympathetic.

FRITZ SATTLER

June 3, 1905—September 12, 1937

Fritz Sattler studied natural sciences in the Universities of Tübingen and Freiburg (Germany) from 1925 to 1931. He went to Bonn in 1932 where he studied plant pathology at the Institut für Pflanzenkrankheiten. In 1934 he went to Giessen where he completed his graduate study and received his doctorate in 1935.

From 1935 to 1936 he served in the Abteilung für Pflanzenkrankheiten des Institutes für Pflanzenbau und Pflanzenzüchtung der Ludwigs-Universität, Giessen. In 1937 he was employed as plant pathologist and agronomist by the seed firm of Gebr. Dippe A. G. in Quedlinburg, Germany.

Dr. Sattler was a man of sterling qualities, untiring diligence, and, withal, showed great promise. His untimely death cut him off in the vigor of life.

JACOB JOSEPH TAUBENHAUS

October 20, 1885—December 13, 1937

Jacob Joseph Taubenhaus was graduated from the National Farm School, Doylestown, Pennsylvania, in 1904. He received the degree of Bachelor of Science in 1908 and the degree of Master of Science in 1909, both from Cornell University. He was granted the degree of Doctor of Philosophy by the University of Pennsylvania in 1913.

From 1913 to 1916 he was, at first, Assistant Pathologist, and, later, Associate Pathologist at the Delaware Agricultural Experiment Station. In 1916 he was Russell lecturer for the Massachusetts Horticultural Society. From 1916 to the time of his death, he was Chief of the Division of Plant Pathology and Physiology at the Texas Agricultural Experiment Station. From 1924 to 1937 he was also a member of the graduate faculty of the Texas Agricultural and Mechanical College.

Dr. Taubenhaus was an unusually enthusiastic worker. He did notable work on the diseases of the sweet pea, sweet potato, and cotton. In addition to being a charter member of The American Phytopathological Society, he was a member of a number of other scientific and agricultural societies. He was deeply religious and active in Zionist affairs.

ERRATA, VOLUME 27

Page 15, table 6, footnote a, *read* 50[1]—From same host etc. *for* 50—From same host etc.

Page 112, line 10 *read* His spring *for* This spring.

Page 148, table 1, *read*

Group and species	Moderately resistant	Susceptible
Chickasaw plum, *Prunus angustifolia* Marsh	×	
Sumac, *Rhus* sp.		×
for		
Chickasaw plum, *Prunus angustifolia* Marsh		×
Sumac, *Rhus* sp.		

Page 584, line 6, *read* cupric *for* cuprous.

Page 735, line 16, *read* Lind[3] *for* Lind[2].

Page 1003, table 1, *read* Himalaya | Mild | Extreme

for Himalaya | " | Extreme

Page 1016, line 6, also page 1020, table 4, *read* Pyronema *for* Pyronena.

Page 1120, table 1, *read* Cerelose *for* Cerulose.

Page II of Index, column 1, 4th line from bottom, *transfer* tabacum (See also Wildfire) to 13th line from bottom, to *read* stewarti, etc.

tabacum (See also Wildfire.)

Page IV,[1] column 1, line 24 *read* Chestnut, breeding *for* breeding.

Page XIII,[1] column 1, 5th line from bottom *read* 109 *for* 948.

Page XX,[1] column 1, line 42, *read* Virulence, factors *for* factors.

Page XXI,[1] column 2, *read* 729 *for* 739.